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Research Trends in Nutrition Science

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PREFACE

In an age defined by rapid advancements in science and technology, the landscape of nutrition science stands as a testament to humanity's unending pursuit of knowledge and well-being. The book you hold in your hands, "Research Trends in Nutrition Science," is a chronicle of this dynamic journey—one that traverses the intricate pathways of our understanding of nutrition and its profound impact on our health and lives.

Nutrition science is no longer confined to simple dietary recommendations. It has blossomed into a multidisciplinary field that delves into the molecular intricacies of nutrients, the physiological responses of our bodies, and the complex interplay between genetics, environment, and lifestyle choices. With each passing day, new discoveries emerge, challenging old paradigms and illuminating the uncharted territories of our nutritional landscape.

This book serves as a compass for those navigating the intricate waters of nutrition research. Its chapters are not only a reflection of the current state of the field but also a glimpse into its promising future. Here, you will find a compilation of cutting-edge studies, innovative methodologies, and thought-provoking insights from experts who have dedicated their lives to unraveling the mysteries of nutrition.

As we delve into the pages of this book, we are reminded that nutrition science is not a static entity. It is a living, breathing entity that adapts, evolves, and transforms as our knowledge deepens. From exploring the gut microbiome's role in metabolism to unraveling the epigenetic underpinnings of dietary effects, the chapters presented here illuminate the intricate tapestry that nutrition weaves within our bodies.

We extend our gratitude to the contributors, researchers, scientists, and scholars who have generously shared their expertise and findings. Their commitment to advancing our understanding of nutrition science is the foundation upon which this book stands.

In an era marked by unprecedented challenges to global health and well-being, the significance of nutrition science has never been more evident. This book aspires to serve as a beacon of knowledge, guiding both seasoned researchers and curious minds alike towards a deeper comprehension of the profound relationship between what we consume and how we thrive.

Editors

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PROTEIN: IT'S APPLICATION IN FOOD INDUSTRY

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Abstract:

Proteins and isolates proteins are used in food industries for their functional properties like fat binding capacity, emulsification, hydration, enhancement of flavor retention and improvement of mouth-feel, foaming ability and stability, gelation, adhesion, rheological properties (viscosity, elasticity), coatings, edible films, texture improvement in products such as beverages, ice creams, cheese, yogurt etc. They improve functional and nutritional properties of products by fortifications. Proteins are used as enzyme in food industry e.g. starch, meat, dairy, wine processing etc. which modify the food properties due to their ability to act as catalysts, transforming raw materials into improved food products. The enzymes e.g. chymosin, lipase, lysozymes, lactoperoxidase, acid proteinase, neutral proteinase or peptidase, ά-amylase, β-xylanases, oxidoreductase, lipase, protease, maltogenic ά-amylase, asparginase, lipoxygenase, pectianses, cellulases, hemicelluloses, laccase, glucomylases, transglutaminase, liapse, actidin, tyrosianse etc. are widely used at world level for processing industries like starch, bakery, juice, beverages, dairy. Shelf life of proteins is important for maintain quality and safety. It can influence by external factors, such as light, heat, moisture, contamination etc. The price of animal proteins are double than plant proteins due to excellent functional properties. The plant proteins contain anti nutritional factors which inhibit the complete absorption during digestion. Novel protein sources like microalgae, insects, and duckweed products are commercialized based on nutraceutical and nutritional properties.

Introduction:

"Protein" is derived from a Greek word meaning `first' or `primary,' because of the fundamental role of proteins in sustaining life (Morris, 1992). Proteins are nitrogen-containing compounds made of up amino acids unit. They are the major structural component of muscles and other tissues in the body (Jay *et al.*, 2004). Proteins composed of

22 different amino acids linked together by a peptide bond and the resulting chain is called polypeptide. They have similar basic structure but differ in their side chains. This difference in side chains gives the proteins their specificity and functionality (Clark, 2003). Proteins that are utilized in food processing are of various origins, and can roughly be classified into animal proteins (gelatins), vegetable proteins (e.g. peanut protein, soy protein, wheat proteins, Almond protein, canola meal protein etc.), and animal derived protein (e.g. milk proteins). However, many vegetable proteins require processing to provide food material having acceptable functional properties such as emulsification, oil and water absorption, texture modifications, colour control and whipping properties, which are primarily attributed to the protein characteristics. Food proteins provide essential amino acids that the body needs for protein synthesis and various physiological functions. They also contribute to the sensory and functional properties of food, such as texture, flavor, and stability.

Protein is a macronutrient that is essential for the growth, repair, and maintenance of cells and tissues in the human body. Proteins serve numerous functions in the body, including acting as enzymes, transporters, structural components, and regulators of various biological processes. The concentration of amino acids such as methionine, lysine, tryptophan and threonine, are usually lower in plant-based sources. Thus, combination of plant based foods is proposed to increase the overall protein quality of a meal (Chardigny & Walrand, 2016). Isolated proteins are used in food industries for their functional and nutritional properties, for instance-emulsification, hydration, fat-binding capacity, enhancement of flavor retention and improvement of mouthfeel, foaming ability and stability, gelation, adhesion, rheological properties (viscosity, elasticity), coatings and films (Lam and Nickerson, 2013, De Castro *et al.,* 2017, Tarhini *et al.,* 2017).

Extracted protein

Extracted proteins refer to proteins that have been isolated or extracted from their natural sources, such as plants or animal tissues, through various processing techniques. These extraction processes typically involve breaking down the complex food matrix and separating the protein fraction from other components, such as carbohydrates, fats, and minerals (Lou *et. al.,* 2010). Extracted proteins can be used as ingredients in the food industry to enhance the nutritional profile, functional properties, and sensory characteristics of food products. They can be processed further into various forms, including protein concentrates, isolates, and hydrolysates, depending on the desired

applications and functionalities. Protein concentrates contain a higher proportion of proteins along with some of the original components present in the source material. They are typically obtained through the removal of non-protein components using techniques like filtration or precipitation. Protein isolates are more purified forms of protein concentrates, with higher protein content and minimal amounts of other components. They undergo additional processing steps, such as filtration, ion exchange, or chromatography, to obtain a highly concentrated protein product.

The process by which the proteins from the cell are recovered for the analysis purpose is called protein extraction. The purification process may separate the protein and non-protein parts of the mixture, and finally separate the desired protein from all other proteins. Two different methods of fractionation are typically used –dry fractionation and wet fractionation. Dry fractionation of pulses is used to obtain pulse protein concentrate (50 to 60% protein) from milled dehulled pulse flour. This typically involves use of a high speed pulveriser (Pin mill) resulting in very fine (-350 mesh or -60 microns) pulse flour. After milling fractionation is carried out using air classification using a fluidized tower system. The air classification system results in the separation of pulse protein concentrates (2 to 20 micron) and starch concentrate (70 to 75% starch, 20 to 40 micron). Wet fractionation of pulses is typically used in obtaining protein isolates (70 to 92% protein) from pulses. The process involves dehulling of the pulses followed by solubilizing the protein, by alkali treatment, and separation of starch. The soluble protein fraction is then separated by centrifugation as the supernatant. The protein isolate is then recovered from the soluble protein fraction by isoelectric precipitation at the isoelectric pH of the respective pulse proteins. In the final step the precipitate obtained is washed with water to remove any impurities present and protein isolate powder is obtained by spray drying, drum drying or freeze drying (Aurelia *et al.,* 2009).

The process also yields pulse starch of high (98% starch) purity. High protein flours (up to 75% purity in some cases) have been successfully produced from wheat, soybean, beans, lentils, chickpeas and peas using air classification (Wolf *et al.,* 2002). As animal materials frequently contain proteases that can hydrolyze proteins and decrease their functionality, appropriate precautions are required to slow down or prevent these reactions (e.g., thermal inactivation or processing at cold temperatures). Some extraction processes call for a second extraction of the precipitate using similar pH as in the first

extraction or higher in order to extract any remaining proteins in the precipitate and increase protein recovery (Boye *et al.*, 2010).

Lawhon and co-workers found the extractability of protein in aqueous medium to be higher when using higher flour to water ratios than lower ratios. Water ratios influenced nitrogen extractability more significantly than pH. During alkaline extraction pH and temperatures must be carefully chosen to avoid extensive denaturation and lysinoalanine has been found in both edible and non-food proteins only after alkali treatment. Some reports have shown that it can be generated in various proteins when heated under non-alkaline conditions. The acid extraction technique is generally used less frequently than the alkaline extraction technique and, as with alkaline extraction, processing conditions can influence the yield and purity of the finished product. Acetone, ethanol, acetone–methanol, chloroform–methanol, tricholoroacetic acid and ethanol are examples of solvents and solvent mixtures frequently used for protein precipitation. Food proteins have their isoelectric point in the range pH 4–5, this pH range is frequently used for protein recovery in the food processing industry. Washing steps ultimately increases the efficiency of oil and protein extraction. To maintain desired functionality, the pH of the precipitate must be appropriately adjusted prior to drying. Enzyme extraction which damage and degrade plant cell walls, so increasing the permeability of the oil in the oilseed. The use of lipases or phospholipases to breakdown fats, as this could result in the generation of off-flavors in the finished product. Ultrasound assisted extraction alters the physiological and biological properties of plant extracts, especially proteins. During ultrasonication, a mechanical effect occurs therefore protein might undergo structural changes (Gulseren *et al.,* 2007).

High lipid bioavailability can interfere with protein extraction; lipid separation can be applied to enhanced protein extraction. Protein hydrolysates are proteins that have been enzymatically or chemically broken down into smaller peptide chains or individual amino acids. This process is known as hydrolysis. Protein hydrolysates are often used in specialized applications, such as sports nutrition products or infant formulas, where rapid digestion and absorption of amino acids are desired. Overall, extracted proteins provide a valuable source of dietary protein and are utilized in various food products to improve nutritional value, enhance functional properties, and meet the diverse needs and preferences of consumers.

Techno-functional properties of proteins in food

Proteins in food systems possess various techno-functional properties that contribute to the texture, structure, stability, and overall quality of food products (Geerts *et al.,* 2017; van der Goot *et al.,* 2016; Garba and Kaur, 2014). Here are some important techno-functional properties of proteins in food systems:

Emulsification: Proteins have emulsifying properties, allowing them to stabilize oil-in-water or water-in-oil emulsions. They can form a protective layer around fat droplets, preventing their coalescence and maintaining the stability of emulsions. This property is crucial in products like salad dressings, mayonnaise, and creamy sauces.

Foaming: Proteins can create and stabilize foams by entrapping air or gas bubbles within a protein matrix. Foaming properties are essential in the production of aerated food products, such as meringues, mousses, and whipped toppings. Proteins with good foaming properties can provide stability, volume, and texture to these products.

Gelation: Many proteins have the ability to form gels under appropriate conditions. Gelation occurs when proteins undergo a structural rearrangement, forming a three-dimensional network that entraps water or other liquid components. Protein gels contribute to the texture, stability, and sensory attributes of products like gelled desserts, jellies, and protein bars.

Water-binding capacity: Proteins have water-binding properties, which help improve the moisture retention and juiciness of food products. This property is especially important in meat products, as proteins help to retain water during cooking, reducing cooking loss and maintaining the desired texture and succulence.

Texture modification: Proteins can contribute to the textural properties of food products by forming a network that influences viscosity, elasticity, and mouthfeel. This property is particularly significant in products like bakery goods, pasta, and meat analogs, where proteins play a crucial role in defining the desired texture and bite.

Solubility and dispersibility: Proteins exhibit varying solubility and dispersibility characteristics in different food systems. This property influences the ease of protein incorporation into food products and their functional behavior. Soluble proteins are desirable in applications like protein-fortified beverages, while dispersible proteins are suitable for powdered formulations and instant food products.

Heat-induced coagulation: Many proteins undergo coagulation or denaturation when subjected to heat. Heat-induced coagulation is utilized in various food processes, such as

the formation of meat patties, protein-based baked goods, and tofu. Coagulation helps impart structure, texture, and stability to these products.

Enzymatic activity: Some proteins possess enzymatic activity, which can have both positive and negative effects on food systems. Enzymatic activity can contribute to desirable flavor development in processes like fermentation and aging. On the other hand, it can lead to undesirable changes in food quality, such as browning or off-flavors.

Functional roles of food proteins in food systems

Function	Mechanism	Food
Solubility	Hydrophilicity	Beverages
Water absorption and binding	Hydrogen bonding of water, entrapment of water, ionic hydration	Meat sausages, cakes & breads
Viscosity	Water binding, hydrodynamic size & shape, thickening	Soups, granies & salad dressings, deserts, beverages
Gelation	Water entrapment & immobilization, network formation, proteins act as adhesive material.	Meats, gels, cakes, bakeries and cheese
Cohesion adhesion	Hydrophobic, ionic & hydrogen bonding	Meat, sausages, pasta & baked foods, colour control in bread, textured products
Emulsification	Adsorption and film formation at interfaces	Sousages, soup, cakes, dressing, ice cream, beverages, coffee whitness
Foaming	Interfacial adsorption and film formation	Whipped toppings, ice cream, cakes, deserts
Fat & flavour binding	Hydrophobic bonding, entrapment, binding of free fat, adsorption, release	Low fat bakery products, doughnuts

(Source: Kinsella *et. al.,* 1985; Boye *et. al.,* 2010; Lam and Nickerson, 2013)

Flavor and aroma contribution: Proteins can interact with other components in food systems, contributing to flavor and aroma characteristics. They can bind and carry volatile compounds, impacting the release and perception of flavors. Proteins can also undergo

Maillard reactions, leading to the development of desirable cooked flavors in baked goods, roasted meats, and coffee.

Nutritional value: Proteins are an important source of essential amino acids and provide nutritional value in food systems. They contribute to the body's growth, repair, and maintenance processes, making proteins a vital component of a balanced diet.

Research studies

Feng *et al.* (2016) stated that ovalbumin includes hydrophobic and hydrophilic groups and acts as emulsifier, foaming agent, and gel, in food products. Ovalbumin has the potential to be a carrier for bioactive compounds in functional foods. Microparticles were produced with whey protein were developed as texture modifiers and flavor carriers in food products (Leon *et al.*, 2016). Zein, a hydrophobic protein mainly found in corn kernels, is insoluble in water and soluble in alcohol solutions, which provides the potential to encapsulate lipophilic bioactive agents (Patel and Velikov, 2014 and Chen *et al.*, 2014). Zein (core) and b-Lg (shell) nanoparticles were used to encapsulate tangeretin, a poor watersoluble bioactive flavonoid. Thus, it could be added to aqueous based food products as a functional ingredient. Elzoghby *et al.*, 2012 reported that Soy protein isolates (SPI), from soybean, is also a very used protein-based material in food emulsification, bioactive compounds delivery, films, and tissue engineering (e.g., membranes) applications, due to soy protein abundance in nature, biodegradability, and low cost. Accordance to Lohcharoenkal *et al.* (2014) wheat gliadin is a natural protein with good viscoelastic and bioadhesive properties, high tensile strength, excellent gas barrier properties, low price, and large-scale availability. Potential application of wheat gliadin nanoparticles as a new foaming agent in food industry (Peng *et al.*, 2018).

The selection of nanoscale for protein structures (e.g., nanohydrogels) is usually required to improve the stability and minimize their influence on color, texture, and flavor of the final product (Neethirajan and Jayas, 2011). Protein-based nanostructures are usually used to enhance the food product nutritional value without affecting sensory properties. Jarpa-Parra *et al.* (2017) carried out that replaced egg and milk as the principal sources of proteins in angel food cakes and muffins. In another research, replacement by lentil protein affected the specific gravity and consistency index of batters, which reduced the mean area of air cells but increased the number of air cells per unit area, and thus, the volume of the final product was not affected. The development of a gluten-free, 100% pulse based cracker snack using several pulse fractions that included green and red lentil, among

other flours and proteins Han *et al.* (2010). In the bakery field, substituted wheat flour in bread with lentil protein produced a bread of intermediate quality with lower volume than the control and a greener color. Depending on the level of supplementation, it had similar or higher hardness than the control bread (Aider *et al.,* 2012).

Enzymes are protein molecules functioning as specialized catalysts for chemical reactions. Enzymes have always been important to food technology because of their ability to act as catalysts, transforming raw materials into improved food products. Food processing enzymes are used in starch processing, meat processing, dairy industry, wine industry and in manufacture of pre-digested foods (Chaudary *et al.* 2015). The most widely used enzymes available for commercial use in winemaking are: pectinases, glucanases, xylanases and proteases-to improve the clarification and processing of wine, glycosidase-the release of varietal aromas from precursor compounds, urease-the reduction of ethyl carbamate formation, glucose oxidase-the reduction in alcohol levels (Mojsov, 2013). Protein isolates from red lentil showed almost twice higher fat adsorption when using ultrafiltration (115 g oil/100g material) compared to isoelectric precipitation (226 g oil/100g material) to obtain the isolate (Boye *et al.* 2010). Protein isolate from corn germ had four times higher water holding capacity (WHC) when tested at pH 7 (WHC 9 ml/g), compared to pH 10 ((WHC 2.2 ml/g) (Hojilla- Evangelista, 2012). The pH-dependence of functional properties is especially observed with solubility, and the final pH conditions can affect the final solubility more than the protein extractions conditions. Applications such as foams and emulsion demand high protein solubility. Understanding the techno-functional properties of proteins allows food manufacturers to select appropriate protein sources and optimize their usage in different food systems to achieve the desired functionality and quality of the final product.

Applications of protein in food industry

Proteins are used in the formulation of meat products to improve texture, binding, and water-holding capacity. They can be used as binders, emulsifiers, or extenders, enhancing the overall quality and yield of products like sausages, burgers, and meatballs. Proteins, particularly casein and whey proteins are widely used in the production of various dairy products. They contribute to the texture, stability, and viscosity of products such as cheese, yogurt, ice cream, and milk-based beverages. Proteins, such as wheat gluten or soy protein, are used in the baking industry to improve dough elasticity, volume, and structure. They enhance the texture and overall quality of bread, cakes, and pastries.

Protein-based beverages have gained popularity in recent years due to their nutritional value and health benefits. Protein powders derived from sources like whey, soy, or pea are added to sports drinks, nutritional shakes, and meal replacements to provide essential amino acids and promote muscle recovery. With the increasing demand for plant-based foods, proteins derived from sources like soy, peas, lentils, and nuts are used to develop meat and dairy alternatives. These proteins are processed and formulated to mimic the texture and flavor of animal-based products, providing viable options for vegetarians and vegans.

Protein sources like casein and whey proteins are used in the production of infant formula to provide a balanced and easily digestible source of nutrition for babies. Protein powders and bars are widely consumed as nutritional supplements for athletes, bodybuilders, and individuals seeking to increase their protein intake. These products often contain various protein sources, including whey, casein, soy, or plant-based proteins. Proteins, such as egg proteins or soy lecithin, are used as emulsifiers in food products like salad dressings, mayonnaise, and sauces. They help stabilize the emulsion, preventing separation and improving the texture and mouth feel of the product. Proteins can be fortified with essential amino acids, vitamins, minerals, and other nutrients to enhance the nutritional profile of food products. This is commonly done in the production of fortified cereals, bars, and beverages. Proteins can be used to modify the texture of food products. For example, hydrolyzed proteins or enzymes can be used to tenderize meat, while gelatin can be used to provide a smooth and creamy texture to desserts like mousses and puddings. These are just a few examples of the applications of proteins in the food industry. Protein functionality and versatility make them an essential ingredient in various food products, contributing to taste, texture, nutritional value, and overall consumer satisfaction.

Enzymes have always been important to food technology because of their ability to act as catalysts, transforming raw materials into improved food products. The main values of enzymes are their substrate specificity. When working under mild conditions of ion concentration, temperature and pH. Enzymes can modify and improve the functional, nutritional and sensory properties of ingredients and products, and therefore enzymes have found widespread applications in processing and production of all kinds of food products. Food technologist selects those enzymes which can improve one particular unit operation of food production. Proteins play a crucial role in the food industry due to their

functional properties, nutritional value, and ability to enhance product quality. Here are some common applications (Bloom *et al.,* 2005; Fernandes, 2010b; Riberiro *et al.,* 2010) of proteins in the food industry:

A. Dairy Industry
B. Baking Industry
C. Juice Industry
D. Brewing Industry
E. Meat Processing

(A) Enzymes play a vital role in the dairy industry, contributing to various processes involved in milk and dairy product production. Here are some common uses of enzymes in the **dairy industry:**

1. Cheese production: Enzymes (Chymosin, lipases, lysozymes) are crucial in cheese production, where they aid in the coagulation and curd formation process. Rennet, a complex enzyme mixture containing the enzyme chymosin, is traditionally used to coagulate milk proteins (casein) and form a curd. Chymosin cleaves a specific peptide bond in the casein molecules, resulting in the separation of curds (protein) from the liquid whey. Additionally, other proteolytic enzymes, such as proteinases and peptidases, are used to develop the desired flavor, texture, and ripening characteristics of different types of cheeses (Bhoopathy, 1994).

2. Yogurt and fermented dairy products: Enzymes are used in the production of yogurt and other fermented dairy products. Lactic acid bacteria cultures produce their own enzymes, such as lactase, which converts lactose (milk sugar) into lactic acid, contributing to the sour taste and thickening of yogurt. In lactose-free dairy products, commercial β-galactosidase, lactase enzymes are used to hydrolyze lactose into glucose and galactose, making the product suitable for lactose-intolerant individuals.

3. Milk processing: Enzymes are used in milk processing to modify and enhance certain properties. For instance, lactoperoxidase, an enzyme naturally present in raw milk, can be used to control microbial growth and enhance the microbiological quality of milk. Acid proteinases ENZYMES used for milk coagulation. Enzymes like lactase or lactose hydrolyzing enzymes can be used to convert lactose into glucose and galactose in lactose-reduced or lactose-free milk products.

4. Whey processing: Enzymes are used in the processing of whey, the liquid by-product of cheese or yogurt production. Proteases and peptidases can be used to break down whey

proteins into smaller peptides and amino acids. This enzymatic action is utilized in the production of whey protein concentrates and isolates, which are used as ingredients in various food products, including protein shakes, bars, and sports nutrition products.

5. Milk flavor enhancement: Enzymes are used to enhance the flavor of milk and dairy products. Aminopeptidases are important for the development of flavor in fermented milk products, since they are capable of releasing single amino acid residues from oligopeptides formed by extracellular proteinase activity. Proteases and lipases have significant role in dairy food industry. The other minor enzymes having limited applications in dairy processing include glucose oxidase, catalase, superoxide dismutase, sulphydryl oxidase, lactoperoxidase, and lysozymes. Glucose oxidase and catalase are often used together in selected foods for preservation.

(B) Enzymes play a crucial role in bakery technology, contributing to various aspects of dough development, texture improvement, and shelf life extension.

Here are some common uses of enzymes in bakery applications:

1. Dough development: Enzymes are used to improve dough handling and development. Proteases and amylases are commonly used to break down proteins and starches in the dough, respectively. This enzymatic action helps relax the gluten network, improve dough extensibility, and enhance the overall workability of the dough during mixing and processing (Sanz Penella *et al.*, 2008).

2. Gluten enhancement: Enzymes like fungal proteases, also known as fungal alpha-amylases, are used to modify gluten in dough. These enzymes break down specific peptide bonds in gluten proteins, resulting in improved dough elasticity and increased gas retention capacity. This is particularly important for the production of bread with desired volume, texture, and crumb structure (Di Cagno, 2003).

3. Texture improvement: Enzymes are used to improve the texture of bakery products. Lipases can be used to modify the fat content, resulting in improved dough handling properties, enhanced crumb softness, and increased shelf life. Enzymes like xylanases and cellulases can modify the structure of fiber components, leading to improved texture, moistness, and softness in baked goods (Cauvain and Young, 2006).

4. Shelf life extension: Enzymes contribute to the extension of shelf life in bakery products. Enzymes like amylases and hemicellulases break down starches and non-starch polysaccharides, respectively, resulting in reduced retrogradation and staling of bread and

other bakery products. These enzymes help maintain freshness, softness, and moisture retention over an extended period.

5. Crumb structure control: Enzymes can be used to control the crumb structure in bakery products. Enzymes like transglutaminase (TG) can improve the structural integrity and volume of bread, resulting in a finer and more uniform crumb structure. Enzymatic control of crumb structure is particularly important in the production of specialty bread and baked goods.

6. Gluten-free baking: Enzymes are extensively used in gluten-free baking to compensate for the absence of gluten. Enzymes like proteases, amylases, and cellulases are used to improve the texture, volume, and shelf life of gluten-free bakery products. These enzymes help break down complex components, enhance dough handling, and improve the overall quality of gluten-free baked goods (Di Cagno *et al.*, 2003).

It's important to note that the selection and usage of enzymes in bakery applications depend on several factors, including the specific bakery product, desired characteristics, processing conditions, and regulatory requirements. The optimal dosage and processing conditions for enzymes may vary, and it is crucial to follow the recommendations provided by enzyme suppliers and adhere to regulatory guidelines for safe and effective enzyme usage in bakery technology.

(C) Enzymes are widely used in the juice industry to improve the production process, enhance quality, and optimize the extraction of juices from fruits.

Here are some common uses of enzymes in the juice industry:

1. Juice extraction: Enzymes play a crucial role in the extraction of juice from fruits. Pectinases are commonly used enzymes that break down pectin, a complex polysaccharide found in the cell walls of fruits. By degrading pectin, enzymes help to loosen the cell structure, increase juice yield, and facilitate the release of trapped juice during pressing or extraction processes.

2. Clarification: Enzymes are utilized to clarify juice by removing haze-causing compounds and insoluble particles. Proteases and pectinases are often employed to break down proteins and pectins, respectively, which can contribute to cloudiness or sedimentation in juices. These enzymes help improve juice clarity and stability, enhancing the visual appeal and shelf life of the product (Lee *et al.*, 2006; Sandri *et al.*, 2012).

3. Flavor enhancement: Enzymes are used to enhance the flavor profile of juices. For example, enzymes like beta-glucosidase can hydrolyze glycosidic bonds, releasing aromatic

compounds from their bound form. This enzymatic action helps unlock flavor precursors and enhance the fruity, floral, or herbal characteristics in juices.

4. Enzymatic deactivation: Enzymes are also used to deactivate or inactivate certain enzymes naturally present in fruits that may negatively impact juice quality or stability. For instance, enzymes like polyphenol oxidase (PPO) and peroxidase can cause browning or off-flavors in juices due to enzymatic oxidation reactions. By using heat or enzymatic treatments, these unwanted enzymes can be deactivated, preserving the color and flavor of the juice.

5. Enzymatic modification: Enzymes can be used to modify the composition and properties of juice. For example, enzymes like amylases can break down complex carbohydrates, such as starch, into fermentable sugars, facilitating fermentation in fruit juices that are used for alcoholic beverages. Enzymes can also be used to modify the texture, mouthfeel, and consistency of juices by targeting specific components like pectins or cell wall polysaccharides.

It is important to note that the specific enzymes and their application in the juice industry may vary depending on the fruit type, desired characteristics of the juice, and production process. The selection and optimization of enzymes depend on factors such as fruit composition, processing conditions, desired juice quality attributes, and regulatory requirements.

(D) Enzymes play a crucial role in the brewing industry, aiding in the breakdown of complex carbohydrates and proteins during the brewing process. Here are some common uses of enzymes in **brewing:**

1. Mashing: Enzymes are used during mashing, the process of converting starches in malted grains (typically barley) into fermentable sugars. Specifically, enzymes called amylases, including alpha-amylase and beta-amylase, break down starch molecules into shorter chains and fermentable sugars like maltose. This enzymatic action is essential for the production of fermentable sugars needed for yeast fermentation.

2. Wort clarification: Enzymes like proteases and beta-glucanases are used to clarify the wort, the liquid extracted during mashing. Proteases help break down proteins that can cause haze in the final beer, while beta-glucanases break down beta-glucans, which contribute to viscosity and filtration challenges. These enzymes aid in improving the clarity and stability of the wort (Aastrup *et al.*, 2004).

3. Adjunct use: Enzymes can be used when adjunct grains, such as corn or rice, are added to the brewing process. Adjuncts are grains with lower enzymatic activity compared to barley. Enzymes like glucoamylase, also known as amyloglucosidase, can be added to convert complex sugars in adjuncts into simpler, fermentable sugars.

4. Enzymatic modification of malt: Enzymes can be used to modify malted grains to achieve specific brewing characteristics. For example, proteases can be employed to modify the protein content in malt, affecting the beer's foam stability and mouthfeel. Enzymes can also be used to modify the starch content to create low-carbohydrate or low-calorie beers.

5. Enzymes for specialty beers: In the production of specialty beers, enzymes can be used for unique purposes. For example, enzymes like amyloglucosidase or invertase can be used to break down complex sugars in high-gravity brewing, where a higher concentration of fermentable sugars is desired. Enzymes can also be used in the production of gluten-free beers to break down gluten proteins.

6. Filtration and clarification: Enzymes are employed during the filtration process to aid in the removal of unwanted compounds and improve beer clarity. Enzymes like papain or bromelain can be used as proteases to break down haze-forming proteins and improve beer filtration efficiency.

It is important to note that the usage and application of enzymes in brewing may vary depending on the specific beer style, desired characteristics, and brewing techniques employed. Beer is the World‘s most widely consumed alcoholic beverage; it is the third most popular drink after water and tea (Nelson, 2005). Brewers carefully select and optimize enzyme usage to achieve the desired outcomes while ensuring the quality and consistency of the final product.

(E) Enzymes play a significant role in meat processing, contributing to various aspects of meat quality, texture, and flavor.

Here are some common uses of enzymes in meat processing:

1. Tenderization: Enzymes such as papain (from papaya) and bromelain (from pineapple) are used to tenderize meat. These enzymes break down the connective tissues and proteins in meat, resulting in a tenderer and easily chewable product. Tenderization enzymes are often used in the production of marinated meats, cured meats, and meat-based products like jerky (Koohmaraie Zor *et al.*, 2009).

2. Flavor development: Enzymes like proteases and lipases can be used to enhance the flavor of meat products. These enzymes break down proteins and lipids, releasing amino

acids, peptides, and fatty acids that contribute to the development of desirable flavors and aromas. Flavor-enhancing enzymes are commonly used in processes like fermentation and aging of meats, such as dry-aged beef or cured sausages.

3. Curing and flavor fixation: Enzymes, such as nitrate reductase, are used in the curing process of meat products like ham, bacon, and sausages. These enzymes convert added nitrate or nitrite into nitric oxide, which reacts with myoglobin in meat to form a stable pink color and develop characteristic flavors associated with cured meats.

4. Texture improvement: Enzymes like transglutaminase (TG) are used to improve the texture and binding properties of meat products (Whitehurst and van Oort, 2010). TG can bind proteins together, enhancing the meat's texture, improving juiciness, and increasing the yield of formed or restructured meat products like nuggets, patties, or deli meats.

5. Fat reduction: Lipolytic enzymes can be used to reduce the fat content in meat products. These enzymes break down triglycerides into glycerol and free fatty acids, leading to the extraction and separation of fat from meat. This process is often used in the production of lean meat products or low-fat ground meats.

6. Shelf life extension: Certain enzymes, such as proteases and antimicrobial enzymes can be used to extend the shelf life of meat products. These enzymes help inhibit the growth of spoilage microorganisms, enhance the antimicrobial properties of marinades or coatings, and improve the overall microbial safety and quality of meat products.

It is important to note that the use of enzymes in meat processing requires careful control and optimization of enzyme activity, dosage, and processing conditions to achieve the desired outcomes while ensuring food safety and quality. Regulations and guidelines regarding enzyme usage in meat processing may vary in different regions, so it is essential to comply with local regulatory requirements and industry standards.

Application of enzymes in food industries

Industry	Enzymes name	Actions
Dairy	1. Acid proteinases 2. lactoperoxidase 3.β-galactosidase, actases 4. Neutral proteinases and Peptidases 5. Chymosin, lipases, lysozymes	Milk coagulation Cold sterilisation of milk: milk replacers for calves Breaking down lactose to glucose and galactose in milk processing to avoid lactose intolerance. Accelerated cheese ripening; de-bittering;

		enzyme modified cheese; production of hypoallergenic milk-based foods Cheese manufacturing
Baking	1. β-xylanases 2. α-amylases 3. Lipases 4. Oxidoreductase 5. Proteases 6. Glucose oxidase 7. Maltogenic α-amylases 8. Lipoxygenase 9. Asparginase	Improving dough handling and dough stability. Degrading starch in flours and controlling the volume and crumb structure of bread. Improving stability of the gas cells in dough. Giving increased gluten strength. Reducing the protein in flour Oxidative reaction with gluten to make weak dough stronger, drive and more elastic Improves self-life of bread and cack Bleaching and strengthening dough Reduces the amount of acrylamide formed during baking
Juice	1. Pectinases 2. Laccase 3.Amylases, glucoamylases 4. Naringinase and limoninase 5. Cellulases, hemicellulose	Degrading pectins which are structural polysaccharides present in cell wall. Increase the overall juice production. Increasing the susceptibility of browning during storage. Breaking down starch into glucose. Clarifying cloudy juice, especially for apple juice. Acting on compounds that cause bitterness in citrus juices. Acting on soluble pectin hydrolysis and on cell wall components with pectinases. Lowering viscosity and maintenance of texture.
Starch processing	1. α-amylases 2. β-amylases 3. Pullulanases	Cleaving α-1, 4-glycosidic bonds in the inner region of the starch. Causing a rapid decrease in substrate molecular weight and viscosity. Producing low-molecular weight

	4. Amylopullulanases 5. Glucoamylases 6. Glucose isomerases 7. Isoamylases 8. Glycosyltransferases	carbohydraetes, such as maltose and —β- limit dextrin. Attacking α-1, 6-linkage, liberating straight-chain oligosaccharides of glucose residues linked by α-1, 4-bonds. Cleaving α-1, 4-linkages from non reducing ends of amylose, amylopectin and glycogen molecules. Attacking α-1, 4-linkages and α-1, 6- linkages from the non-reducing ends to release β-d-glucose. Catalysing isomerization of glucose to fructose. Transferring a segment of a 1, 4- α-Dglucan chain to a primary hydroxyl group in a similar glucan chain to create 1, 6- linkages. Hydrolysing α-1, 6-linkages in glycogen and amylopectin. Increasing the number of branched point to obtain modified starch with improved functional properties such as higher Solubility, lower viscosity and reduced retrogradation.
Brewing	1. α-amylases 2. Proteases 3. β-glucanases 4. Amyloglucosidases 5. Pullulanases 6. α-acetolactatedecarboxylases (ALDC) 7. Pentosanases, xylanases	Hydrolysing starch to reduced viscosity; Liquefying adjunct; Increasing maltose and glucose content; Increasing soluble protein and free aminonitrogen (FAN). Malt improvement. Improving yeast growth. Hydrolysing glucans into oligomers and leading to lower viscosity and better filterability; Improving wort separation. Increasing glucose content. Increasing 1% fermentable sugar in light beer.

		Hydrolysing α-1, 6 branch points of starch. Securing maximum fermentability of the wort. Converting α-acetolactate to acetoin directly. Decreasing fermentation time by avoiding formation of diacetyl. Making beer taste right Hydrolyzing pentosans of malt, barley and wheat. Improving extraction and beer filteration.
Meat	1. Tyrosinase 2. Acid proteases 3. Elastase 4. Glutaminase 5. Papain/ficin/bromelain 6. Lipase 7. Transglutaminase 8. Actidin	Cross-link meat protein, enhances functional properties of enzymes. Improve flavouring, nutritional and functional properties of proteins. Converts animal carcasses into flavourous compounds under mild condition without by-product formation. Tenderize meat; improve the commercial value of the low value meat. Enhances flavour of the meat protein due to L-glutamic acid. Meat tenderization. Hydrolyze both animal and plant roteins. Increases protein dispersability, palpability, solubility and digestibility. Hydrolyze triglycerides; Improves flavour in sausages. Improves the structural properties of the processed or cooked meat. Improve tenderness in processed meat.

(Source: Bloom *et al.,* 2005; Fernandes, 2010b; Riberiro *et al.,* 2010, Choudhary *et al.*, 2015)

Shelf life of protein:

The shelf life of proteins in food products can vary depending on several factors, including the type of protein, processing methods, packaging, storage conditions, and the presence of other ingredients. Here are some general guidelines for protein shelf life in different food products:

1. Fresh or raw meat: Fresh meat, such as beef, poultry, or seafood, typically has a relatively short shelf life due to its perishable nature. It is recommended to consume fresh meat within a few days of purchase or follow the expiration date specified by the manufacturer. Proper refrigeration at temperatures below 40°F (4°C) is crucial to slow down bacterial growth and extend the shelf life.

2. Processed meat products: Processed meat products like sausages, deli meats, and canned meats have a longer shelf life compared to fresh meat. Depending on the processing methods, packaging, and preservatives used, these products can have a shelf life ranging from a few weeks to several months. It is important to follow the storage instructions provided by the manufacturer and check for any signs of spoilage before consuming.

3. Dairy products: Dairy proteins, such as milk, cheese, yogurt, and butter, have different shelf lives depending on their processing and storage conditions. Pasteurized milk, for example, typically has a shelf life of a few weeks when properly refrigerated. Cheese and yogurt can have longer shelf lives, ranging from weeks to months, depending on the type and storage conditions. It is important to check the expiration date and follow proper storage guidelines to ensure the quality and safety of dairy products.

4. Plant-based proteins: Plant-based protein products, including tofu, tempeh, and plant-based meat alternatives, often come with specific expiration dates indicated by the manufacturer. These products may have a shorter shelf life compared to their animal-based counterparts. It is essential to follow the recommended storage conditions and use-by dates to maintain their quality and safety.

5. Protein powders and supplements: Protein powders, such as whey, soy, or plant-based protein powders, typically have a longer shelf life compared to perishable food products. When stored in a cool, dry place and sealed properly, these powders can remain usable for months or even years. However, it is still important to check the expiration date provided by the manufacturer and ensure the powder's quality before consumption.

It is worth noting that the shelf life of proteins can be influenced by external factors, such as exposure to light, heat, moisture, and contamination. It is crucial to handle and store food products properly to maintain their quality and safety. Always refer to the packaging labels, storage instructions, and expiration dates provided by the manufacturer for specific guidelines on protein shelf life in different food products.

Market value of protein

The market price of protein can vary significantly depending on several factors, including the type of protein, source, quality, supply and demand dynamics, production costs, and market conditions. Here are some examples of protein sources and their market prices as of my knowledge cutoff in September 2021:

Animal-based proteins: a. Beef: The price of beef can vary depending on factors such as the cut, quality, and market conditions. Higher quality cuts like tenderloin or ribeye tend to have higher prices compared to ground beef or lower-quality cuts. b. Chicken: Chicken prices can vary based on factors like cuts (breast, thighs, wings), organic or conventional, and market conditions. c. Seafood: Prices for different types of seafood, such as salmon, shrimp, or tuna, can vary depending on factors like species, quality, availability, and whether it is wild-caught or farmed.

Plant-based proteins: a. Soy: Soy protein prices can fluctuate depending on factors like supply and demand dynamics, global crop conditions, and the use of soy for different applications (food, feed, biofuel, etc.). b. Pea: Pea protein has gained popularity as a plant-based protein source, particularly in the development of meat alternatives and sports nutrition products. Prices can vary based on factors like quality, processing methods, and market demand. c. Rice: Rice protein, commonly used in vegan protein powders and bars, can vary in price based on factors such as quality, production volume, and market demand.

It's important to note that market prices can change over time due to various factors, including fluctuations in commodity prices, changes in supply and demand, weather conditions, and geopolitical factors. Additionally, regional variations in prices can occur due to factors like transportation costs, import/export regulations, and local market conditions. For the most up-to-date and specific information on protein market prices, it is advisable to consult industry reports, market analyses, and reputable sources that track commodity prices or refer to relevant trade platforms and exchanges.

Factor affecting protein choice

When selecting a market for protein products, several factors should be considered to ensure potential success and profitability. Here are some key aspects to consider:

1. Market demand: Assess the demand for protein products in the target market. Look for indications of a growing or stable demand for protein-based foods, including both animal-

based and plant-based options. Consider factors like consumer preferences, dietary trends, health and wellness awareness, and the popularity of specific protein sources.

2. Target audience: Identify the specific target audience for your protein products. Determine whether you are targeting athletes and fitness enthusiasts, health-conscious consumers, individuals with dietary restrictions (vegetarians, vegans), or a broader consumer base. Understanding the demographics, preferences, and purchasing power of your target audience is crucial for market selection.

3. Competition: Analyze the competitive landscape in the target market. Identify existing protein product manufacturers, brands, and their market share. Evaluate their product offerings, pricing strategies, distribution channels, and marketing efforts. Assessing the competition will help you understand market saturation, identify potential gaps or niches, and develop a unique value proposition.

4. Regulatory environment: Familiarize yourself with the regulatory requirements and standards in the target market. Ensure that your protein products comply with local regulations regarding labeling, packaging, safety, and quality standards. Be aware of any specific regulations or certifications required for certain types of proteins or claims (e.g., organic, non-GMO).

5. Distribution channels: Evaluate the distribution channels available in the target market. Determine whether you will sell your protein products through retail stores, e-commerce platforms, foodservice establishments, or a combination of channels. Consider factors like logistics, shelf space availability, competition within distribution networks, and the preferences of your target audience.

6. Price and affordability: Analyze the pricing dynamics and affordability of protein products in the target market. Assess the price ranges of similar products and determine whether your pricing strategy aligns with the market's expectations. Consider factors like production costs, profit margins, and the willingness of consumers to pay for premium or specialty protein products.

7. Sustainability and ethical considerations: Increasingly, consumers are prioritizing sustainability and ethical practices when making purchasing decisions. Evaluate whether the target market has a strong demand for sustainably sourced proteins or products with certifications like Fair Trade, MSC (Marine Stewardship Council), or organic.

8. Market growth potential: Consider the growth potential of the target market. Assess factors like population growth, economic stability, urbanization, and consumer behavior

trends. Look for indications of a growing middle class or an expanding market for healthy and functional foods, as these factors can contribute to long-term market potential.

The characteristics of techno functional property of protein increase to the market value due to having property to develop texture (e.g. meat) (Wild *et al.*, 2014). The anti-nutritional factors in the product, thus limiting its applicability (Teekens *et al.*, 2016) and decrease the price. The anti-nutrients present in mostlty pulses and plant protein can bind to nutrients and inhibit the complete absorption during digestion. It is crucial to conduct thorough market research, including market surveys, competitor analysis, and consumer insights, to make an informed decision about entering a specific protein market. Additionally, consulting with industry experts, trade associations, and local partners can provide valuable insights and guidance in market selection and entry strategies.

Conclusion:

Proteins are also the major structural components of many natural foods and isolated proteins are used in foods as ingredients because of their unique functional properties e.g. their ability to provide desirable appearance, texture or stability. Proteins are used as gelling agents, emulsifiers, foaming agents and thickeners. Proteins can be processed to obtain enriched flours, concentrates or isolates for various foods and by-products to fulfill the rising demand of protein alternatives among various industries and consumers. The restriction on the use of extracted and isolated proteins from such sources for food and feed applications lies in the fact that these “new” proteins have to pass the Novel Food regulation law. Food analysts are interested in knowing the total concentration, type, molecular structure and functional properties of the proteins in foods. The enzyme technology offers excellent potentials for many food industries to help meet the challenges they will face in coming years. Protein can be provided from low cost and naturally occurring food components, thus being candidates to be used as green formulation ingredients in the food industry. A deep knowledge of proteins properties allows their manipulation and takes advantage of them for novel food applications.

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NUTRITION: THE SECRET OF HEALTHY LIFE

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Nutrition: What is it?

Nutrition has a major role in how human health develops. The immune system is strengthened, pregnancy is safer, mental alertness is raised, and the risk of chronic diseases like diabetes, cardiovascular disease, etc. is reduced thanks to improved nutrition.

A safe pregnancy, lowered chance of chronic disease development, and assistance in maintaining a healthy weight are all benefits of a nutritious diet.

According to the proverb "You are what you eat," persons who eat properly are often healthier and more successful.

Malnutrition results from consuming foods that are not proper for your diet, which is dangerous for human health. In the modern world, malnutrition is very common, including being overweight and undernourished.

To advance health and wellbeing, the WHO provides professional advice and recommendations on malnutrition.

What makes nutrition crucial?

One must consume adequate macronutrients (proteins, carbohydrates, fats, and water) and micronutrients (vitamins and minerals) for the body to function effectively, grow appropriately, and maintain health.

As we've seen, processed, sugary, fatty, and salted foods deplete the body and impair its ability to function. Contrarily, eating fresh, whole-food meals fuels the body by supplying it with the energy it needs, promoting metabolic activity, addressing micronutrient deficiencies, preventing the development of chronic diseases, and enhancing general health and wellbeing.

The seven primary types of nutrients that the healthy human body needs to survive are proteins, carbohydrates, fats, vitamins, minerals, fibre, and water. Although humans may survive with fewer micronutrients (vitamins and minerals), we require a lot of macronutrients.

Proteins:

Proteins help our bodies' immune systems and muscles to function better. Amino acids make up protein. Furthermore, the proper operation of our body depends on these amino acids. Our bodies use protein to make new tissues and repair damaged ones. It aids in the production of hormones and enzymes.

Lentils, low-fat dairy, tofu, almonds, seeds, and other legumes are all vegetarian options.

Non-vegetarian: Meat include chicken, beef, fish, turkey, and more varieties

Carbohydrates:

Foods high in carbohydrates are thought to be sources of energy. They provide the body with the energy it needs to operate.

Our energy comes from up to 65% of carbohydrates. They are the body's main fuel source since they are so easily converted into energy. Usually, this energy comes in the form of glucose, which all of the tissues and cells in our body can utilise right away.

There are two different kinds of carbs: simple carbohydrates and complicated carbohydrates. The primary cause of the formation of ketones is carbohydrates. Bread, potatoes, spaghetti, soda, chips, cookies/biscuits, puddings, cakes, sugar, bananas, etc. are all good examples of carbs.

Fats:

You should consume fats because they can provide your body with energy. While some dietary fats, such as monounsaturated fatty acids and poly unsaturated fatty acids, may be healthier for you than others, such as saturated fatty acids and trans fats, all dietary fats are still essential to your diet since they aid in the production of hormones, cell growth, energy storage, and nutrient absorption.

Blood pressure management and healthy skin depend on fat. The two different types of fats are saturated and unsaturated. Products like milk, butter, cheese, and even chocolates all contain saturated fats. Oils from sunflower, soybean, cardamom, and maize are a few examples of unsaturated fats.

Vitamins:

Vitamins are necessary substances that are crucial to the well operation of our bodies. Several of these include vitamin A, vitamin B, vitamin C, vitamin D, vitamin E, vitamin K, vitamin B-6, and vitamin B-12. Most of these vitamins are given to us every day. Vitamins D and K are naturally produced by our body.

Minerals:

Macro-minerals are required in higher concentrations than trace minerals. The important macrominerals and their functions are as follows:

- Calcium is necessary for the proper functioning and formation of bones
- Phosphorus is a component of cell membranes
- Magnesium helps in activation of enzymes
- Sodium controls blood pressure and fluid equilibrium
- Chloride maintains fluid equilibrium and encourages the formation of digestive juices
- Potassium helps in nerve impulse transmission and muscle contraction
- Sulphur is present in all living tissues

Trace minerals, on the other hand, are required in extremely little levels but play a number of crucial roles in our systems. The body needs a variety of essential trace elements, including selenium, iodine, iodine salts, copper, zinc, manganese, copper, and iron.

Benefits of healthy eating: Most of us believe that eating well can help us maintain a healthy weight. Healthy nutrition, however, goes beyond simply preserving your weight.

Protein, vitamins, minerals, and lipids are some of the nutrients that provide you energy and help your body work properly.

Here are a few advantages of healthy eating:

1. Preserves cardiac health

Hypertension, or excessive blood pressure, is becoming a major problem in India. The disorder can cause heart attacks, cardiac failure, and strokes.

Up to 80% of heart disease and stroke diagnoses may be avoided by making lifestyle changes, such as increasing physical activity and eating healthfully.

A diet high in salt and saturated fat can cause high blood pressure and high cholesterol. By controlling blood pressure and cholesterol levels, a balanced diet rich in fruits, vegetables, whole grains, and low-fat dairy will help reduce your risk of heart disease.

2. Enhances health

One of the fundamentals of preserving good health and wellbeing is eating a balanced diet that contains items from several food groups.

The appropriate foods will provide you the energy you need for the entire day, improve your focus, and improve your ability to sleep.

It has been demonstrated, for instance, that the Mediterranean diet, which features lots of fish, healthy fats, and vegetables, encourages mental wellbeing and lessens depression.

3. keeps immune system healthy

Essential vitamins and minerals are required for our immune system to function at its best. A nutritious diet supports immune system maintenance, infection prevention, and the avoidance of immunodeficiency diseases.

4.Enhances energy levels

More energy is one of the first benefits of switching to a healthy diet. By avoiding added fats, sugar, and refined carbohydrates, you can prevent changes in your blood sugar levels. Refined carbohydrates include, for instance, white bread and desserts.

Whole grains, unprocessed fruits and vegetables, and whole grains are the best sources of carbohydrates. You can maintain constant blood sugar and energy levels as a result.

Regular, little meals help to maintain energy levels. A nutritious breakfast also provides you with energy for the remainder of the day.

5. Postpone the impacts of ageing

Tomatoes, berries, avocados, almonds, and shellfish are just a few examples of foods that are rich in particular vitamins and minerals that are good for the skin.

As an illustration, tomatoes contain vitamin C, which encourages the synthesis of collagen, giving your skin a firmer appearance and delaying the development of premature ageing. Berries, which are high in vitamins and antioxidants, promote skin cell regeneration.

6. Could increase lifespan

The act of metabolising, or the process by which dietary components are broken down, stresses the body even though food is necessary for survival. Overeating puts the body under additional stress, which could reduce its lifespan. Diets rich in nutrients and devoid of processed foods, according per PubMed Central, lengthen life expectancy.

What is nutrition for kids?

The human body develops a robust organic growth when it is fed nutrient-rich diet as children. Observing eating habits improves newborns' and kids' nutrition:

- A range of vegetables and fruits.
- Whole grains.
- Dairy products with low fat and no fat.
- Various protein-rich foods.

Nutritional importance during pregnancy

A pregnant woman's metabolism, immune system, physical metamorphosis, and active organ functioning are all positively impacted by a healthy diet high in nutrients. In general, pregnancy is a time of accelerated brain development for humans. Prenatal nutrition is the essential fuel that gives a baby a great deal of power.

The neural and brain development of the unborn child is immediately impacted when the mother does not consume enough calories, protein, and fatty acids during her pregnancy. Pregnant women who eat a balanced diet will never experience vitamin or mineral deficiencies in their unborn children. Nutritional needs and the influencing factors

The following are the various variables that affect dietary requirements:

1. Age

The nutritional needs you have greatly depend on your age. For example, a child's requirement for vitamin C rises with age. Calcium and phosphorus requirements both increase during childhood but decrease as people mature.

The gastrointestinal tract frequently absorbs less magnesium and vitamin B12 in elderly persons. Additionally, older people produce less vitamin D from their skin. Lutein, a carotenoid found in spinach, may help older people considerably ward off age-related macular degeneration.

2. Gender

Additionally, gender has a considerable impact on the amount of nutrients required. Women need more calcium and iron than males do. Additionally, since vitamin D aids calcium absorption, women are typically advised to take calcium and vitamin D combined. Folate and other B vitamins, calcium, vitamin D, and iron are essential nutrients for embryonic development during pregnancy. Additionally, during pregnancy, there is an increased need for numerous nutrients, including calcium, iron, and zinc.

3. Way of living

Your nutritional demands have been impacted by the type of lifestyle you have. Diet is the main part of lifestyle that has an impact on health. Obesity is a common health problem in urban societies, as does a poor diet and its consequences. A bad lifestyle can be

detected using BMI. Urban living leads to nutritional problems, such as eating fast food and bad foods, which raises lifestyle diseases like diabetes, cholesterol, etc.

4. Physical exercise

Your dietary requirements depend on the amount of physical exercise you get. For the body to maintain its fluid equilibrium, electrolytes are a class of vital nutrients. Although too much salt is unhealthy for us, salt and the electrolytes magnesium, calcium, potassium, and chloride are essential for health. Make sure your food has enough salt to restore your salt levels.

Although many energy drinks contain electrolytes, they are not ideal if you are attempting to lose weight because they also contain a lot of sugar.

5. Cultural background

Culture has an impact on how often individuals eat, how food is prepared, and in some cases, whether or not they are able to impose limits like eliminating meat and dairy from the diet. But cultural effects can shift; when people move to a new nation, they usually adopt certain native eating habits.

6. Foods obtainable nearby

There are many different things available at supermarkets in large cities. However, if you reside in a smaller city or town, what is available locally could have a significant impact on your culinary preferences.

Indians may also benefit from indigenous cuisine like rice and chapati over oats or bread as sources of carbohydrates. This is due to the fact that these foods are traditional fare and better suit Indian physiologies.

7. Food and dietary traditions

Food is often used by people to maintain their feeling of cultural identity. People from various ethnic origins cook a variety of meals. For instance, the reason why idli makes you think of South India and pasta makes you think of Italy.

Conclusion:

An individual needs to eat roughly 2000 calories each day, often spaced out over 3 to 6 meals.

Around half of what we eat should consist of colourful fruits and vegetables; the wider the rainbow, the better.

Therefore, about 25% of everything we consume should be made up of proteins including meat, chicken, fish, beans, dairy, and nuts. Carbohydrates like whole grains and starchy vegetables should make up approximately 25% of your diet.

Our added sugar and fat intake should be kept to a minimum, and we should only rely on the aforementioned sources to provide all of our energy and fat requirements. Healthy fats can be found in proteins and foods like avocados and olive oil, whereas healthy carbohydrates can be found in fruit and dairy products.

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FERMENTED FISH PRODUCTS AS A POTENTIAL SOURCE OF GAMMA AMINOBUTYRIC ACID

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Abstract:

Gamma-aminobutyric acid is the chief inhibitory neurotransmitter in the developmentally mature mammalian central nervous system. It plays a very important role in the working of nervous system of various mammals such as humans, cats, rats etc. Along with its role in nervous system GABA is also used as a food supplement that has vast benefits over sleep management, anxiety and stress management etc. Along with its nutritional benefits it has some pharmaceutical benefit as well. But the production of GABA is not easy and complex procedure and raw materials are required for the production of the same. In recent times it was found that fermented fish products can be a very good source of production of GABA. With proper screening of fermented fish species along with strain improvement, downstream processing, recovery, purification, and analysis it is possible to produce GABA from these fermented fish products. This is comparatively cheaper and easier method to produce organic or natural origin GABA.

Keywords: Gamma-aminobutyric acid, neurotransmitter, *nuoc mam, aekjeot, umami*

Introduction:

Fermented fish products are valuable nutritional condiments made by combining fish and sea salt. They are generally used as a main ingredient for traditional foods in various cuisines in Asia. In Vietnam, they are called nuoc mam (fish sauce) and are one of the few traditional products manufactured on a large scale throughout the country, with an annual output of approximately 220 million products. In Korea, they are called aekjeot, and are typically used in kimchi to accelerate the fermentation process. On some occasions, they are also used in Korean side dishes and soup or stew to give extra umami (flavour). Thus, they are considered one of the most important sources of dietary proteins. Fish sauce contains up to 20 g/l nitrogen, 80% of which is in the form of essential amino acids.

Glutamic acid, aspartic acid, and lysine are three amino acids mostly present in fish sauce, which contains particularly high amounts of glutamic acid (23 mg/ml). Glutamic acid is a precursor of gamma-aminobutyric acid (GABA), and also helps to give the characteristic flavour of fish sauce.

GABA is a four-carbon, non-protein amino acid that is widely present in bacteria, plants, and vertebrates. It is principally formed by a α-decarboxylation reaction of L-glutamic acid or its salts, and catalysed by glutamic acid decarboxylase, whose biochemical properties have been reported previously. GABA is served as a bioactive compound in foods and is seen as a great bioactive natural compound for human health since it exerts several physiological functions and also has positive antioxidant, anti-diabetes, hypotensive, and anxiety reduction effects. GABA could delay or inhibit the invasion and metastasis of various types of cancer cells in the mammary gland, colon, and hepatic cancer cells. Indeed, GABA- enriched food is required because the GABA content in the typical daily human diet is relatively low. As a result, the development of functional foods containing GABA has been actively increased with a vast variety of GABA- enhanced food products including cereals, sourdough, breads, cheeses, fermented sausages, teas, vegetables, legumes, dairy soy products, alcohol beverages, and especially traditional Asian fermented foods.

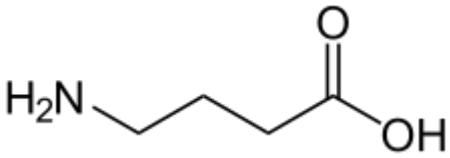

Figure 1: Structure of Gamma-aminobutyric acid

GABA is produced by fermentation with microorganisms has been reported in bacteria, fungi, and yeasts. The best GABA-producing natural strains are *L. paracasei, L. delbrueckii, L. lactis, and L. brevis* isolated from a variety of Italian cheeses, and *Lc. lactis sp*. were screened from cheese starters with the highest level of GABA production (391 mg/kg). Natural GABA-producing strains are found in fermented fish products such as fish sauce.

Sources: Multiple fermented fish products such as nuoc mam, aekjeot, umami

Production procedures:

There have been many attempts for synthesizing GABA chemically or biologically because of the beneficial functions of GABA and the increasing commercial demand.

Biosynthetic methods of GABA may be much more promising than chemical synthesis methods since they have a simple reaction procedure, high catalytic efficiency, mild reaction condition and environmental compatibility. Various biosynthetic techniques have been developed for the efficient production of GABA, including immobilized cell technology, sourdough fermentation.

In order to produce the GABA, fish products are kept in in 20% glycerol at 80 °C. To start the fermentation, starter culture like L. piracies, L. delbrueckii are added. The frozen cultures are periodically plated to check their viability. Salting is one of the oldest traditional and commonly used processing techniques for fish preservation worldwide because of its low production cost and the simplicity of the process. Each fish product sample is mixed with salt at a ratio 7:3. Each mixture (5 kg) is then packed in a 6-L glass jar (17- cm diameter; 27- cm height) and occupied about 90% of total jar volume. Each jar is covered with a glass plate. Fermentation is carried out at ambient temperature (28 °C to 32 °C) for 52 weeks.

Health Benefits of GABA:

Sleep Management:

The most important function of GABA is in our brain. When GABA levels get too low, it's difficult for the body to relax after a stress-induced neurotransmitter release. Low GABA activity leads to anxiety, depression, insomnia, and mood disorders.

Several studies are conducted to study and analyse the effects of GABA on the stress and sleep cycles in humans. Initially due to the inability of GABA to cross blood brain barrier was the major difficulty faced by the scientists in the study of its effects on sleep cycle. But this difficulty was overcome by increasing or adding quantity of the GABA rich substances such as rice, tea etc. into the subject's diet.

From these studies it was found that after the intake of 100 mg GABA Capsule improved feelings upon awakening scores, objectively measured reduced sleep latency, and increased total non-REM along with better sleep time after intervention. It is also observed that trends for improved PSQI, sleep satisfaction, and ease of falling asleep scores and increased light non-REM sleep time and sleep efficiency are increased after the intake of GABA.

Anxiety and stress management:

Multiple studies have been conducted to determine how GABA can be used to treat anxiety. GABA is a natural brain relaxant that makes us feel good. But GABA can also help with the prevention and treatment of other health issues.

In some clinical trial, researchers used EEG to measure participants' brain waves after taking either GABA or a placebo. Just one hour after taking GABA, they saw a significant increase in alpha waves, which caused feelings of calm and relaxation.

Controlled hypertension:

The effects of GABA can be used to stabilize blood pressure in people with hypertension. High blood pressure is a factor that affects your risk of having a stroke, heart attack, or heart failure.

One study examined how GABA lowered the blood pressure of adults with diagnosed hypertension. Participants took varying doses of GABA and monitored their blood pressure levels over eight weeks. Those taking 80 milligrams of GABA per day saw a significant drop in blood pressure.

A study conducted by *Yoshida, S., Haramoto, M., Fukuda, T., Mizuno, H., Tanaka, A., Nishimura, M., et al* in 2015 it was found that on consumption of GABA rich rice i.e 16.8 mg GABA in 150 g GABA Rice every day can increases the feeling of calmness in subject resulting in lower amount of stress ultimately reducing the hypertension conditions.

Lower obesity risk:

Obesity is a serious health condition that affects nearly 40% of Americans. It is responsible for an increased risk of hypertension, type 2 diabetes, heart disease, stroke, and osteoarthritis. In a study done in Korea, researchers looked at GABA's possible ability to lower the chances of developing obesity in people.

Problems and challenges:

In recent time with the help of advancement in technology and research field various applications and uses of GABA are determined. But along with these uses there are certain challenges and problems which needs to be addressed

1) Scale up this product in India:

In India here are very few industries who has all the equipment and technology which is required for the mass production of the GABA from very specific sources. Hence production of GABA from these sources is very tedious hectic and costly affair which is a reason not many industries in India tend to do so.

2) Storage of raw materials:

In order produce GABA from marine sources first it is essential to store the raw materials at optimum conditions. As the raw materials mainly consist of aquatic or marine sources it is essential to maintain the temp for the storage of these raw products. Also transport is a major concern in the storage of raw materials as there are high chances of degradation and spoilage of raw materials if not stored in optimum conditions. Due to all these condition storage of the raw material for this becomes very difficult and costly resulting in overall increase in the costing of production.

3) Short consumer acquisition:

In India relative awareness about the food supplements and its benefits is lower compared to other parts of the world. Hence people usually tend not to but the supplements unless they are recommended by doctors. This results in shorter consumer acquisition leading to lower consumption of that particular product.

But with proper awareness and information it is possible to inform people about the benefits of these supplements.

Conclusion:

Processes for high GABA production by microorganisms are summarized here to develop functional foods and to provide natural GABA. Supply of natural GABA and the enriched food is a big challenge for the growing global demand. Therefore, the production of GABA enriched foods by fermentation using beneficial microorganisms is an indispensable process. For food and medicinal industries, further studies will be required to screen various types of GABA-producing microorganisms from as many as possible fermented foods. There is a positive relation between the optimal fermentation condition and GABA synthesis by microorganisms. Since the production of GABA is totally dependent on the biochemical properties of GAD, clarification of biochemical properties of the GAD for the fermenting microorganism facilitates the optimization of fermentation processes. Many factors including pH, temperature, culture time and media additives can be optimized to achieve the maximum GABA production in various microorganisms. These all processes will be directed to higher flexibility of the microbe cultures for a wider application of GABA.

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FOOD ADDITIVES

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Introduction:

Food additives are compounds that are added to food to preserve or improve its safety, freshness, taste, texture, or appearance. Many different food additives have been produced over time to fulfil the needs of food production, as food production on a large scale differs greatly from food production on a small scale at home. Additives are required to guarantee that processed food remains safe and in good shape as it travels from factories or industrial kitchens to warehouses and shops, and finally to consumers.

Only when there is a technological requirement, no consumer misinformation, and a clearly stated technological purpose—such as preserving the food's nutritional value or improving its stability—can the use of food additives be justified. Food additives can be made synthetically or from plants, animals, minerals, or a combination of these. They are purposefully introduced to food to carry out specific technical functions that consumers frequently take for granted. There are thousands of food additives in use, and each one is intended to serve a specific purpose in enhancing the safety or attractiveness of food.

Definition

Food additives preserve natural flavor, increase shelf life, prevents spoilage; improve taste, and appearance of food. Best examples vinegar (pickles), salt (bacon), sulfur dioxide (wine). Food additives can be of natural or artificial. Food additives added to processed food mainly during manufacturing, processing, packaging, storage or transport**.** Now a days with advances in technologies in food processing industries, they serve to meet the modern population food demands through ready-to-eat food products. The advantage of food additives brings us variety to dishes without loss of flavour. Additives added in very small quantities to food but their impact is high.

Food additives are basically chemicals formed by natural/synthetic processes. Human body metabolizes the additives (Eg. MSG- Monosodium glutamate/ glutamate)

using normal biochemical pathways for digestion. It is of utmost importance that these food additives are toxic/ harmful/ safe for human use. The level of food consumption plays crucial factor in determining toxicity. At low levels they are safe and at excess cause toxicity in important tissues and organs. The safety of food additives lies in testing in wide variety of animals. Further studies on their metabolism, genetic toxicity, carcinogenicity and reproduction are of utmost importance. Long term studies in animals brings scientific evidence for toxicity/safety. Salt or sugar act as preservative by removing water out of the cells and retards the growth of spoilage organisms. Chelating agents chelate with calcium and magnesium minerals necessary for functioning of enzymatic reactions involved in food spoilage. E.g. of chelating agent is EDTA (ethylenediaminetetraacetic acid) used in dressings, mayonnaise, sauces, dried bananas. Examples of Anticaking, bleaching, conditioning agents are sodium aluminosilicate, benzoyl peroxide and potassium bromate in salt and flour respectively.

Food additives help in 4 ways by:

- ✓ Enhance nutritional quality of food and eliminates nutritional disorders.
    a. Eg. Iodine added to salt prevents simple goiter.
    b. Vitamin D to milk prevents rickets.
    c. Niacin in bread, cornmeal and cereals reduce pellagra
- ✓ Maintain product quality and freshness.
    a. E.g. Ascorbic acid for packing fresh fruit slices to reduce oxidation process.
    b. Propionates added in bakery products to prevent mould contamination.
- ✓ Maintain desirable qualities in processed foods
    a. E.g. Lecithin (emulsifier) added in ice-creams, salad dressings improve texture and uniform mixture.
    b. Pectin (stabilizers, thickeners) used in jellies.
    c. Liveners used in breads, biscuits and rolls.
    d. Sorbitol (humectants) employed in packaging of shredded coconut.
- ✓ Foods appealing
    a. Flavouring agents and enhancers,
    b. Colouring agents and Sweeteners.

Types of food additives

Several additives serve more than one function in foods. Based on the functions, additives can be divided into six major categories: Preservatives, Nutritional additives, Flavoring agents, Coloring agents, Texturizing agents, Miscellaneous additives.

Preservatives

There are basically three types of preservatives used in foods: antimicrobials, antioxidants, and anti-browning agents. Antimicrobials play a major role in extending the shelf-life of numerous snack and convenience foods. The antioxidants are used to prevent lipid and/or vitamin oxidation in food products. They are used primarily to prevent autoxidation and subsequent development of rancidity and off-flavor. Anti-browning agents are chemicals used to prevent both enzymatic and nonenzymatic browning in food products, especially dried fruits or vegetables.

Nutritional additives

Nutritional additives have increased in use in recent years as consumers have become more concerned about and interested in nutrition. Primary nutritional additives include vitamins and minerals, while other nutritional additives are the food additives used for special dietary purposes as for e.g. Dietary fibers, fat replacers, etc.

Flavouring agent, colouring agents, texturizing agents

Flavoring agents comprise the greatest number of additives used in foods. There are three major types of flavoring additives: Sweeteners (sucrose, fructose, glucose, lactose), Natural and synthetic flavors and flavor enhancers (monosodium glutamate and various nucleotides).

Most coloring agents are used to improve the overall attractiveness of the food. A number of natural and synthetic additives are used to color foods.

Texturizing agents are used in the greatest total quantity. These agents are used to add to or modify the overall texture or mouthfeel of food products. Emulsifiers and stabilizers are the primary additives in this category, While Phosphates and dough conditioners are other chemicals that play a major role in modifying food texture. Phosphates are some of the most widely used and serve a number of functions in foods.

Miscellaneous additives

There are numerous other chemicals used in food products for specific yet limited purposes. Included are various processing aids such as chelating agents, enzymes, and anti-foaming agents; surface finishing agents; catalysts; and various solvents, lubricants and propellants.

The different types of food additive and their uses include:

1) **Anti-caking agents** – stop ingredients from becoming lumpy.
2) **Antioxidants** – prevent foods from oxidizing, or going rancid.
3) **Artificial sweeteners** – increase the sweetness.
4) **Emulsifiers** – stop fats from clotting together.
5) **Food acids** – maintain the right acid level.
6) **Colours** – enhance or add colour.
7) **Humectants** – keep foods moist.
8) **Flavours** – add flavour.
9) **Flavour enhancers** – increase the power of a flavour.
10) **Foaming agents** – maintain uniform aeration of gases in foods.
11) **Mineral salts** – enhance texture and flavour.
12) **Preservatives** – stop microbes from multiplying and spoiling the food.
13) **Thickeners and vegetable gums** – enhance texture and consistency.
14) **Stabilisers and firming agents** – maintain even food dispersion.
15) **Flour treatment** – improves baking quality.
16) **Glazing agent** – improves appearance and can protect food.
17) **Gelling agents** – alter the texture of foods through gel formation.
18) **Propellants** – help propel food from a container.
19) **Raising agents** – increase the volume of food through the use of gases.
20) **Bulking agents** – increase the volume of food without major changes to its available energy.

Common functions of food additives

Use	**Function**
Preservative	These help in preservation of food by increasing its storage life. Example: Preservative like sodium benzoate in squashes
Taste	Food additives improves the taste or appearance of any food product Example: Grazing agents on fruits.
Quality	These improve the quality or stability of the food. Example: Humectants added to mixed dried foods.
Colour and Flavour	These provide the right colour and the improve the flavour. Example: Commonly available colouring agents.

Beneficial functions

Food additives serve useful functions in the interest of processor or manufacturer and consumer of the food. The major functions of food additives are to enhance the shelf life of food, to enhance the consumers acceptability of the food, to reduce wastage and improve yield of the product, facilitate preparation of food, improve color and appearance of food, to improve body and texture of food, improve flavor (aroma and taste) of food, improve and maintain the nutritive value of food.

Negative impact of food additives

Sodium nitrite used in meat converted to nitrosamines, a carcinogenic (cancer causing) chemical released on cooking can cause stomach cancer. Usage of high fats, sugars causes obesity, diabetes and tooth decay, High salt intake in chips leads to risk of high blood pressure, heart attack and stroke. Eating too much food preserved with sugar can cause obesity, tooth decay and diabetes. Sulphur dioxide is allergic, causing asthma. Among antioxidants, Vitamins C and E are natural and safe for use by reducing cancer rates and heart diseases, Tartrazine causes hyperactivity in children.

Conclusion:

Food additives are chemical chemicals that are added to food to preserve or enhance its flavour. The financial advantage of employing food additives is that they make food cheaper and more affordable to the general populace. The disadvantage of food additives is that they have the potential to harm your health when consumed. Some are added merely for flavour, while others are used to ensure that the food does not deteriorate and stays fresh for longer.

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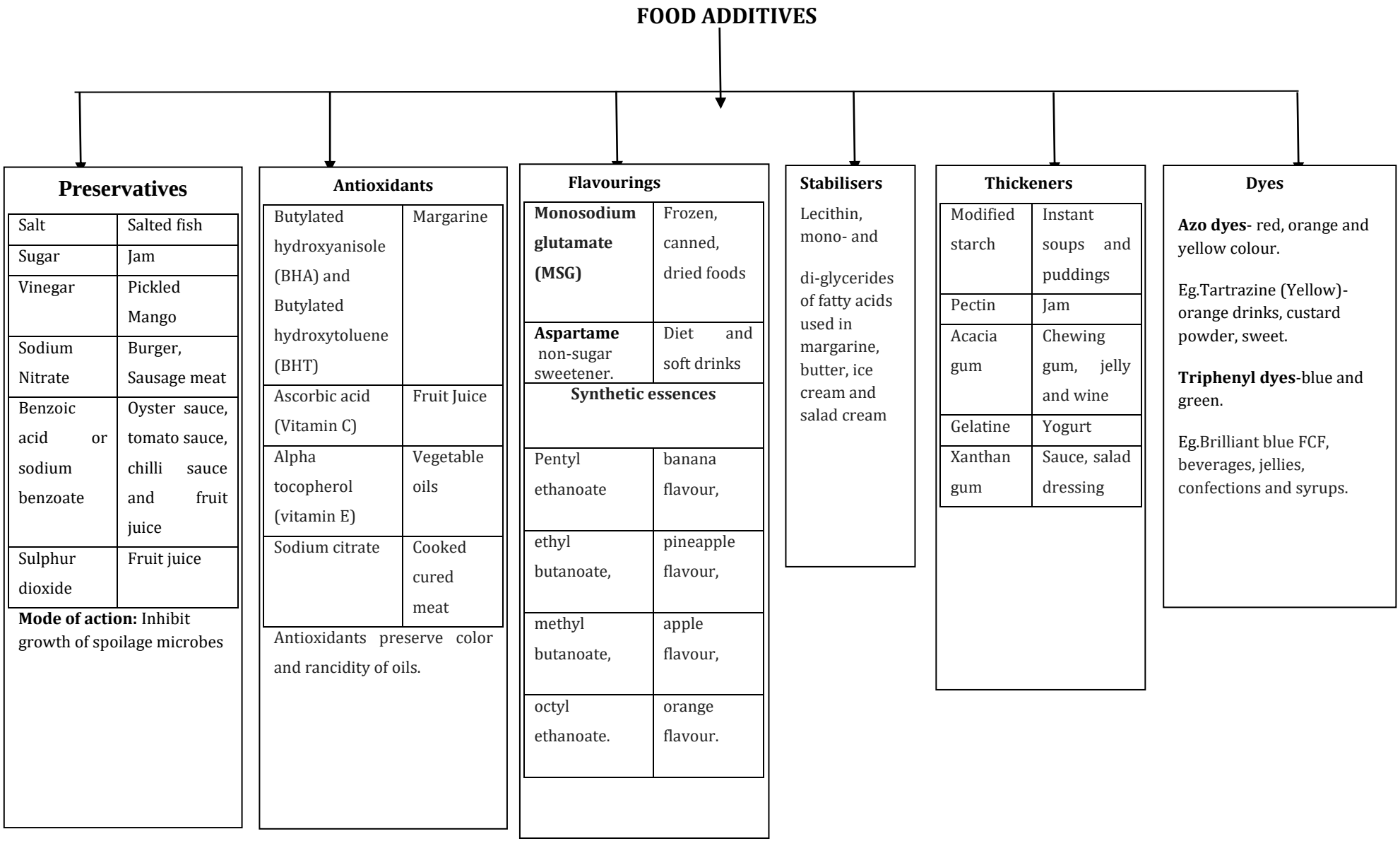
FOOD ADDITIVES
Preservatives
Salt
Salted fish
Sugar
Jam
Vinegar
Pickled Mango
Sodium Nitrate
Burger, Sausage meat
Benzoic acid or sodium benzoate
Oyster sauce, tomato sauce, chilli sauce and fruit juice
Sulphur dioxide
Fruit juice
Mode of action: Inhibit growth of spoilage microbes
Antioxidants
Butylated hydroxyanisole (BHA) and Butylated hydroxytoluene (BHT)
Margarine
Ascorbic acid (Vitamin C)
Fruit Juice
Alpha tocopherol (vitamin E)
Vegetable oils
Sodium citrate
Cooked cured meat
Antioxidants preserve color and rancidity of oils.
Flavourings
Monosodium glutamate (MSG)
Frozen, canned, dried foods
Aspartame non-sugar sweetener.
Diet and soft drinks
Synthetic essences
Pentyl ethanoate
banana flavour,
ethyl butanoate,
pineapple flavour,
methyl butanoate,
apple flavour,
octyl ethanoate.
orange flavour.
Stabilisers
Lecithin, mono- and
di-glycerides of fatty acids used in margarine, butter, ice cream and salad cream
Thickeners
Modified starch
Instant soups and puddings
Pectin
Jam
Acacia gum
Chewing gum, jelly and wine
Gelatine
Yogurt
Xanthan gum
Sauce, salad dressing
Dyes
Azo dyes- red, orange and yellow colour.
Eg.Tartrazine (Yellow)- orange drinks, custard powder, sweet.
Triphenyl dyes-blue and green.
Eg.Brilliant blue FCF, beverages, jellies, confections and syrups.

MACRONUTRIENTS FOR ATHLETIC PERFORMANCE

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Abstract:

Proper nutrition plays a pivotal role in optimizing athletic performance. The three essential macronutrients – carbohydrates, proteins, and fats – serve as the primary sources of energy for athletes. Understanding the significance of each macronutrient and tailoring their intake to individual sport and training requirements can lead to improved endurance, strength, and overall athletic capabilities. This article examines the role of macronutrients in sports performance, providing valuable insights and practical recommendations for athletes aiming to reach their peak potential. The main objective of this article is to provide a comprehensive overview of sports nutrition, with particular emphasis on macronutrient intake and dietary supplements.

Keywords: Macronutrients, Carbohydrates, Proteins, Fats, Sports Nutrition, Athletic Performance, Endurance, Strength.

Introduction:

Nutrients are essential chemical compounds that the body needs to sustain life. They can be categorized into two groups: Macronutrients, which are required in significant quantities, include proteins, carbohydrates, and fats. On the other hand, Micronutrients are necessary in smaller amounts for regular growth and development.

Carbohydrates for energy

Carbohydrates serve as the body's primary and most efficient source of energy during physical activity. They are stored as glycogen in muscles and the liver, readily supplying fuel during intense exercise. Endurance athletes, like long-distance runners and cyclists, benefit greatly from diets rich in carbohydrates as they help delay fatigue, maintain steady performance, and aid in muscle recovery. Complex carbohydrates found in whole grains, fruits, and vegetables are preferred over simple sugars, providing sustained energy without sudden spikes and crashes. To optimize performance, athletes should ensure sufficient carbohydrate intake before, during, and after workouts. Carbohydrate loading, a technique to maximize muscle glycogen stores before endurance events, can

further enhance athletic performance. Dietitians play a crucial role in educating athletes about the importance of carbohydrates and debunking misconceptions about their negative effects. By understanding the advantages of carbohydrates and adjusting their intake based on their specific sport and training needs, athletes can reach peak performance and excel in their athletic pursuits. The majority of dietary carbohydrates should come from complex carbohydrates with a low to moderate glycaemic index, often referred to as "slow carbs." These sources include whole grains, fruits, vegetables, and legumes. It is advisable for athletes to consume a carbohydrate-rich meal with a low glycaemic index about 1-2 hours before training. However, they should not exclude simple carbohydrates with a high glycaemic index from their diet. These carbs are absorbed more quickly, making them ideal for consumption immediately after waking up and within two hours after training. Simple carbohydrates play a vital role in rapidly replenishing glycogen stores after overnight fasting and intensive exercise.

Proteins for muscle repair and growth

Proteins play a crucial role in repairing, recovering, and building muscles. Athletes involved in strength training or resistance exercises require higher protein intake to support muscle synthesis. Amino acids, the building blocks of proteins, aid in repairing tiny muscle tears caused by intense workouts. Optimal sources of lean protein include poultry, fish, eggs, legumes, and tofu, which help athletes enhance muscle development and recovery. Recent research suggests that athletes engaged in intense training should consume about twice the usual recommended daily allowance (RDA) of protein to maintain protein balance. Insufficient protein intake can lead to negative nitrogen balance, increasing protein breakdown and slowing post-workout recovery. This may result in muscle loss, reduced training capacity, and even overtraining. To achieve a balanced or positive nitrogen state, athletes must consume enough protein, typically ranging from 1.5 to 2 grams per kilogram of body weight daily. For resistance exercise athletes and bodybuilders, protein intake may be even higher to meet their energy needs, especially during low-carbohydrate diets. The effectiveness of protein conversion into myofibrillar protein depends on the type of protein consumed. The biological value of a protein is assessed by measuring how efficiently it is absorbed and assimilated into an organism's protein. Excellent sources of low-fat, high-quality protein include skinless chicken, turkey, beef, fish, egg whites, and skimmed milk (casein and whey). Nutritional supplements with high-quality protein include whey, colostrum, casein, milk peptides, and egg protein, while

plant sources like soy have relatively lower value. Ideally, athletes should consume protein every 2.5-3 hours in portions of 30-40 grams for 6-8 meals per day. For those who struggle to meet protein requirements through regular food, protein drinks can serve as suitable substitutes.

Fats for endurance and hormone regulation

Often misunderstood, fats are a vital macronutrient for athletes, particularly those engaged in prolonged endurance activities. Fats serve as an additional energy source during low to moderate-intensity exercise and play a crucial role in absorbing fat-soluble vitamins (A, D, E, and K). Hormone regulation, essential for overall health and athletic performance, is also influenced by fats. Athletes are advised to prioritize healthy fat sources such as avocados, nuts, seeds, and olive oil while limiting saturated and trans fats. For athletes, the recommended fat intake is similar to that of non-athletes or slightly higher. Adequate consumption of essential fatty acids, especially polyunsaturated fatty acids, is of significant importance for athletes. Good sources of essential fatty acids include fatty fishes like salmon, tuna, and mackerel, as well as seeds such as flaxseeds, pumpkin seeds, and walnuts, along with oils like flaxseed oil, soy oil, and olive oil. It is generally recommended that athletes consume a moderate amount of fat, accounting for about 30% of their daily caloric intake. Higher-fat diets are known to better maintain circulating testosterone concentrations compared to low-fat diets. However, athletes aiming to reduce body fat may consume around 0.51g/kg/day of fat. Emphasizing a diet rich in healthy fats is vital for supporting proper physiological functioning in all organisms.

The importance of nutrient timing

Beyond macronutrient composition, nutrient timing is critical for optimizing athletic performance. Pre-workout meals rich in carbohydrates and moderate in protein help top up glycogen stores, while post-workout nutrition should include protein to support muscle repair and carbohydrates to replenish glycogen stores. During prolonged activities, consuming easily digestible carbohydrates like sports drinks can provide a quick energy boost.

Conclusion:

In conclusion, macronutrients are fundamental to athletic performance, with carbohydrates providing energy, proteins aiding in muscle repair, and fats contributing to endurance and hormone regulation. Tailoring nutrient intake to an athlete's specific needs and training demands can lead to significant improvements in performance and recovery.

Balancing these macronutrients alongside proper hydration and nutrient timing forms the foundation of a successful sports nutrition strategy. By understanding and implementing the right dietary approach, athletes can unlock their full potential and achieve peak performance in their chosen sports.

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MILLETS AND NON-COMMUNICABLE DISEASES

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Introduction:

Millets are the traditional staple food of the arid regions of the world. Millets were domesticated thousands of years ago at the dawn of human civilization, and they are regarded as the earliest cereals. There are some indications in Northern China that noodle making originated from two varieties of millet, rye and foxtail millets, more than 4,000 years ago. (Lu *et al.*, 2005). Millets are a group of highly variable small seeded grasses, widely grown around the globe as cereal crops or grains as animal feed and for human consumption which belongs to family Poaceae. Millets are useful since they are grains that are resistant to pests and drought.

The millets can be divided into two categories- major millets and minor millets. The four main major types are Pearl millet (*Pennisetum glaucum*), Foxtail millet (*Setaria italica*), Proso millet or white millet (*Panicum miliaceum*), and Finger Millet(*Eleusine coracana*) and minor millets includes Barnyard millet (*Echinochloa* spp.), Kodo millet (*Paspalum scrobiculatum*), Little millet (*Panicum sumatrense*), Guinea millet (*Brachiaria deflexa*), Browntop millet (*Urochloa ramosa*), Teff (*Eragrostis tef*) and fonio (*Digitaria exilis*), sorghum (*Sorghum* spp.) and Job's tears (*Coix -lacrima-jobi*).

India is the world's top producer of several millets, often known as coarse grains. However, realising its nutritional value and important these are considered as nutri-cereals. India's Pearl Millet (Bajra) and Sorghum (Jowar) together contributed approx 19 % in global production in 2020.

According to WHO, "Non-communicable diseases (NCDs) are a group of diseases that affect individuals over an extended period of time causing socio-economic burden to the nation. The major NCDs share four behavioral risk factors- unhealthy diet, lack of physical activity, and use of tobacco and alcohol." The most common examples of NCDs include cardiovascular disease, diabetes, cancer, chronic respiratory disease, osteoporosis, osteoarthritis, neurological disorders like Parkinson's disease, Alzheimer etc. Obesity is frequently a substantial contributor to the development of a number of non-communicable diseases, severe disability, and early mortality.

According to a WHO data (2017), NCDs are the primary cause of death globally and responsible for 70 percent death worldwide. In India, non-communicable diseases (NCD) were responsible for nearly four out of every 10 fatalities in 1990, or 37.9% of all deaths. In 2008, NCDs accounted for 5.2 million deaths in India. A rising trend in the burden of NCDs is expected in the years ahead. Non-communicable illnesses now account for 61.8% of all fatalities, up 23.9% from 1990, and they account for six out of every 10 deaths in 2016 (India: Health of the Nation's States 2017). The relationship of millets with NCDs are given below:

Cardiovascular disease

Millets are a good source of magnesium, which has been shown to lessen the symptoms of heart attacks and migraines. Millets include a lot of fibre, which helps to decrease cholesterol by removing LDL from the body and boosting the benefits of HDL. In hyperlipidemic rats, finger millet and proso millet decreased plasma triglycerides, which may prevent cardiovascular disease. (Lee *et al.,* 2010). Because millet contains powerful antioxidants including lignin and phytonutrients, heart-related disorders are prevented. Vedamanickam *et al.* (2020) found that the use of millet-based meals, particularly foxtail, finger, sorghum, and wheat-based foods, lowers triglycerides and controls blood sugar levels in diabetes individuals.

Diabetes mellitus

Diabetes mellitus is a chronic metabolic disorder in which blood glucose level remains high due to alterations in carbohydrate, protein, and lipid metabolism. Millets like sorghum contain significant levels of slow digestible starch (SDS), which has the practical feature of delaying the breakdown and absorption of carbs in the gut. By partially preventing the enzymatic degradation of complex carbs, millet phenolics diminish postprandial hyperglycemia, much like alpha-glucosidase does. (Shobana *et al.*, 2009). Blood glucose levels are regulated by finger millet diet, which enhances antioxidant status (Chethan *et al.*, 2008a).

Ugare *et al.* (2011). Reported that Barnyard millet is beneficial for type 2 diabetics especially the dehulled varieties, as the glycemic index for dehulled millet (50.0) and heat treated was 41.7.

Cancer

In their study on the free-radical scavenging capacity of finger millet (Eleusine coracana), Chandrasekara and Shahidi (2010) found that unprocessed brown finger millet had a higher radical scavenging capacity than processed millet and suggested that phytic acid and tannins were the cause of the action (Brunth *et al.*, 2011; Quesada *et al.*, 2011;

Kamara *et al.*, 2012). Tannins, and phytate act as "antinutrients". However, in animals, these antinutrients lower the incidence of breast and colon cancer. It has been shown that millet phenolics may be useful in stopping the development and spread of cancer in vitro (Chandrasekara and Shahidi, 2010)

Neurological disorders

Li *et al.* (2020) reported that millet has anti-inflammatory and neural protective effects by downregulating the expression of the Tnf-α, Il-1β, App, PS1 and tau genes. Free radicals are atoms or molecules with an unpaired number of electrons that can develop when other molecules interact with one another. These free radicals are in charge of the development of many diseases linked to oxidative stress, including Alzheimer's disease, myocardial infarction, atherosclerosis, Parkinson's disease, and auto-immune disorders, among others. Free radical scavenging potential has seen in different millets like kodo millet, finger millet, little millet, foxtail millet, barnyard millet (kudiraivali), great millet (jowar) and their white varieties which helps in preventing this disease.

Osteoporosis

Osteoporosis is a disease that weakens bones, and patients are at a greater risk for sudden and unexpected bone fractures. Although there are many causes of osteoporosis but Low calcium consumption or poor calcium absorption is one of the dietary reasons. Finger millet is a good source of calcium and therefore helps to strengthen bones. It helps in preventing osteoporosis and reduce risk of bone fractures. Finger millet grains contain the highest amount of Ca (162.0-358.0 mg/100 g) when compared to other millet species. (Roopa and Premavalli, 2008**;** Manjula *et al.*, 2015) Calcium present in finger millet plays an essential role in growing children, pregnant women, the elderly (Jideani, 2012**;** Chappalwar *et al.*, 2013). Therefore, eating finger millet can help with the calcium deficiency and osteoporosis issues.

Obesity

In India, obesity is a growing issue and is strongly correlated with a number of chronic illnesses, such as diabetes and cardiovascular disease (CVD). Foods high in dietary fibre help the large intestine work better and slow down digestion and absorption, which lowers the chance of developing chronic illnesses. (Ali *et al.,* 1982; Schneeman, 2000)

Eating millets improves blood lipid profiles and decreases BMI (Anitha *et al.*, 2021). Millets, particularly sorghum, are high in dietary fibre and have distinct chemical and physical properties (bulk to the diet, viscosity, water retention and absorption capacity) that affect the ensuing physiological behaviour. It contributes to hunger satisfaction, heightens satiety, and lowers risk factors for obesity.

Conclusion:

In terms of nutrition and energy content, millets are on par with other cereals. Millets may have health benefits. These are gluten free hence can be included in the diet of celiac disease patients. According to epidemiological studies, higher content of fibres in millets lowers the risk of heart disease, protects against diabetes, lowers the risk of cancer, detoxifies the body and protects against a number of degenerative diseases like metabolic syndrome and Parkinson's disease. Millets being a rich source of minerals can help in eradicating mineral deficiencies diseases like osteoporosis Millets can play an important role in managing non-communicable disease and reduce NCDs related fatalities significantly

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EXPLORING FISH AS A NUTRITIONAL POWERHOUSE

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Introdution:

Fish is an important source of omega-3 fatty acids. These essential nutrients keep our heart and brain healthy omega -3 fatty acids are found in every king of fish, but are especially high in fatty fish. Two omega -3 fatty acids found in fish are EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) some good choices are salmon, trout, sardines, herring, canned, mackerel, canned light tuna, and oysters.

Fish is rich in calcium and phosphorus and great source of minerals, such as iron, zinc, iodine, magnesium, and potassium. Fish is paked with protein, vitamins and nutrients that can lower blood pressure and help reduce the risk of heart attack or stroke. The American heart Association recommends eating fish at least two times per week as part of healthy diet.

Comparing fish calories and Nutrition data can be tricky because the way you prepare your fish can change its nutritional makeup. As an example, ½ of wild Atlantic salmon fillet (154g) contains 280 calories, 12.5g of fat, most of which is monounsaturated and polyunsaturated, 86mg sodium, 39.2g of Protein, and no carbs, fiber or sugers.

Calories	:	280
Fat	:	12.5g
Sodium	:	86mg
Carbohydrates		0g
Fiber	:	0g
Sugers	:	0g
Protein	:	39.2g

1) Ocean Perch (Atlantic raw): 79 calories, 1.4 grams fat, o grams carbohydrate, 15 grams protein

2) Tuna (Yellowfin, fresh, raw): 109 calories, less than one gram fat, 0 grams carbohydrate, 24 grams protein

3) mahimahi (raw): 85 calories, 0.7 grams fat, 0 grams carbohydrate, 18.5 grams protein

4) cod (Atlantic raw): 82 calories, 0.7 grams fat, o grams carbohydrate, 18 grams protein

5) Halibut (raw with skin): 116 calories, 3 grams fat, 0 grams carbohydrate, 20 grams protein

The American Heart Association suggests that fish varieties such as samon, mackerel, herring, lake trout, sardines and albacore tuna is healthy dose of omega – 3

Some of the most nutritious lower – calorie fish varieties

1) Whitefish: (3 Ounces) 115 calories, 5 grams fat, 1.5 grams of omega-3 fatty acids.

2) Pacific black cod: (3 ounces) 70 calories, gram fat, 1.5 grams of omega 3 fatty acids.

3) pacific and jack mackerel: (3 ounces) 134 calores, 7 grams fat, 1.6 grams of omega 3 fatty acids.

4) Anchovies: (3 ounces) 114 calories, 4 grams fat, 1.7 grams of omega-3 fatty acids.

5) salmon: (3ounces) 175 calories 10 grams fat, 1.7 grams of omega 3 fatty acids.

6) Tilapia: (4ounces) 145 calories, 3 grams of fat, 0.1 grams of omega -3 fatty acids.

Mild mental decline is normal serious neurodegenerative ailments like Alzheimer's disease. Many observational studies show that people who eat more fish have slower rates of mental decline. Studies also reveal that people who eat fish every week have more gray matter brain's major functional tissue in the parts of brain that regulate emotion and memory.

Low mood, sadness, decreased energy and loss of interest in life and activities. It is not discussed nearly as must heart disease or obesity depression is currently one of the world's biggest health problem studies have found that people who eat fish regularly are much less likely to become depressed.

Omega-3 fatty acids may fight depression and significantly increase the effectiveness of antidepressant medications. Fish and fish products are among the best dietary source of vitamin D. fatty fish like salmon and herring contain the highest amount.

Health benefits

The vitamins, minerals and fatty acids in fish can provide significant health benefits. The vitamin B_{12} found in fish is crucial for the growth of healthy red blood cells, DNA Reproduction, and nerve function. Consuming enough vitamin B12 is likely to a lower risk of dementia and heart disease. A lack of vitamin B12 is also connected to problems like chronic fatigue and anemia.

Nutrients per serving

Depending on the species, fish can have varying levels of nutrients. The most significant difference is fat content species like samon and tuna are considered fatty, while cod and catfish are lean. This led to variation in the calories

Calories	218
Total fat	4.5g
Saturated fat	1.6g (6%)
Polyunsaturated fat	1g. (8%)
Monounsaturated fat	1.6g.
Cholesterol	97mg (32%)
Sodium	95mg (4%)
Total carbohydrates	0g. (0%)
Dietary fiber	0g (0%)
Sugers	0g (0%)
Proteins	44g
Vitamin D	6.3 mcg (32%)
Calcium	24mg (2%)
Iron	1.2 mg (7%)
Potassium	646mg (14%)
Caffelne	0mg.

Fish is a relatively cheap and accessible source of animal protein for human. In children, inadequate intake of dietary protein could lead to serious health consequences. Including stunted growth and poor development. Hence, the protein component of the human diet is very crucial and an important area of focus when it comes to malnutrition due to its physiological functions. Globally, malnutrition remains a major problem and it is estimated that 47 million children suffer from stunting. Due to lack of micronutrients of vitamin A, iron and iodine which is a source of public health concern in the world. Its consequences include nutritional blindness, impaired learning capabilities, poor growth, and increased morbidity and mortality rate. In many developing countries, malnutrition is a major risk for sickness and death in children. This is mainly driven by lack of access to high quality food products. Fisheries and aquaculture programs, can address and mitigate issues of malnutrition in the world by increasing the access to fish due to its nutritional value. Therefore, increasing fish production could increase the access to fish products and

improve the nutritional status in children which has the potential to end malnutrition and food insecurity.

Chemical composition of fish

The fat content ranges from 0.2 to 25% especially polysaturated fatty acids (PUFAS) which are essential for the proper growth of children and are not associated with the occurrence of cardiovascular disease.

Fats also contribute to the energy supply and aid the adequate absorption of vitamins k, D A and E Fish is vital source of vitamins, especially vitamin A and D of the fats, as well as thiamine, riboflavin and niacin. Vitamin a found in fish is more available in the body compared to plant food and is essential for normal vision and bone growth, also fatty fish contains more vitamin A than the lean types.

Vitamin D found in fish liver and oils, is essential for bone growth because, it is essential for calcium absorption and metabolism. Energy metabolism requires thiamin, niacin and riboflavin. Fresh fish provoids a small amount of vitamin C, which is essential for wound healing, maintaining the integrity of tissue, and assisting in absorbtion of iron in the nerous system.

In recent decades, as peoples concerns about their health have grown, so has their concern about fats. Fatty acids are molecules consisting of one glycerol and three fatty acids that serve as a source of energy in our body and are deposited in the meat, muscles, and liver. When fat is ingested, lipase break it down into one glycerol and three fatty acids, while a few fatty oils molecules are pass through intact through the intestine. The ingested fat is at initial storage in the liver, the muscular of subcutaneous inner layer and then broken down as needed to provide energy.

Phosphorus, calcium, iodine, iron, selenium, fluorine and zinc are among the mirerals found in fish and are extremely “bioavailable” ensuring that they are readily consumed by the organism. Iron is critical for the formation of hemoglobin in the blood, which would be responsible for distributing oxygen across the body.

Calcium is critical for the development and mineralization of bones as well as the normal operation of tissues and the central neuron. It also plays a significant role in the clotting of blood. When young fish are consumed with their bones, the phosphorus, calcium, and fluorine. Consumption is greatest. Zinc is needed for growth performance function of immune system and the maintenance of healthy skin. Iodine found in aquatic aquatic food is necessary for hormones that control body metabolism, growth and proper

behavioral development in chidren children. Fish clearly provide more to people's diets than just high quality proteins As a result, fish can be a staple to every diet, avoiding starvation which, make these nutrients readily accessible to absorption by organs.

Polyunsaturated fatty acid types

Animal oils, like pork, and butter are rich in saturated fatty acids Fish oil is an unsaturated fatty acid. Fish oil is an unsaturated fatty acid similar to animal oil. Unsaturated fatty acid similar to animal oil. Unsaturated fatty acids make up the majority of vegetable fats, although saturated fatty acids like those found in coconut and palm oils are also present. The persistent stability of saturated fatty acids causes them to harden and become while at cold temperatures. It is easy to store and does not easily strip when exposed to heat or pressure. Saturated fatly acid are problematic because they contribute to a number of circulatory and vascular issues saturated fatty acids, that harden at low temperatures, can cause atherosclerosis, angina and stroke by raising cholesterol levels, and they can also alter blood flow. Some saturated fatty acid such as myristic acid C14/0, stearic acid C18/0, monounsaturated fatty acid as palmitoleic acid C16/1, oleic acid C18/1.

Unsaturated fatty acids on the other hand do not solidify and exist in liquid form at low temperatures due to their structural instability. They strip quickly when heat or pressure is applied and spoil quickly. Unsaturated fatty acids are recognized to offer a variety of health benefits unsaturated fatty acids linolenic acid (ALA) C18/3, linoleic acid C18/2 arachidonic acid (AA) C20/4, n-6 eicosapentaenoic acid (EPA) C20/5, n-3, and docosahexaenoc acid (DHA) C22/6 n-3 are those that have a physiologically vital role for children. The location of the first omega double bond, the carbon atom at the and of carbon chain (the CH3 radical) within the fatty acid molecule structure is used to classify unsaturated fatty acids.

The essential fatty acids ALA, linoleic acid, and AA are required for optimal growth and health, but are not produced in animals bodies, so they are classified as essential fatty acids. Wild fishes have higher level of omega-3 PUFAs than farmed fish. Cold-water fishes contents contain greater amount of long chain n3PUFAs, which aid in their adaptation to the cold temperature.

Animals have limited ability to synthesize EPA and DHA (long-chain fatty acids) from ALA because they can not produce omega-3 fatty acids (short-chain fatty acids) Grape seed oil, soybean oil, corn oil, sunflower oil, and cotton seed oil are high in omega -6 fatty

acids, Linoleic acid, linoleic acid, and AA are all omega – 6 fatty acids. Oleic acids belong to the class of omega – 9 fattly acids, and make up more than 80% of olive oil.

Consumption of PUFAs by children

Omega – 3 fatty acids are essential for children's health. Infacts that were fed powdered formula with high grades of omega – 3 fatty acid had better eye – hand coordination, attention and social skills, as well as higher intelligence quotient (IQ) test results. It was also discovered that consuming long chain plyunsaturated fatty acids (LCPUFA's) during pregnancy lengthened the pregnancy and lowered the frequency of premature diliveries.

According to oslen et. al children of moms who took fish oil during pregnancy had a lower risk of developing asthma in their teenage years. According to certain studies, powdered formula containing omega-3 helps preterm babies growth and cognitive development

Food fish quality and safety

Fish is Vulnerable to contaminating by pollutants such as heavy metals that threaten their safety for human consumption. Heavy metals are classified as elements having high atomic weight and density of at least five times greater.

Fish accumulate heavy metals by uptake through the gills and the skin when in contact and can bioaccumulate and biomagnify them to toxic level for human consumption.

Omega – 3 (n-3) omega – 6 (n - 6) and omega – 9 are all good example (n - 9). Fish oil (for example, sardine (10.14 EPA 10.66 DHA) Menhaden (13 17 EPA, 8.56 - DHA) salmon (13.20 EPA, 18.23 DHA) cod liver (9.90 EPA, 10.97 DHA), Herring (6.27 EPA, 4.21 DHA) and fish such as cavior, black and red (2.74 EPA, 3.80 DHA) Values are g/100g.

Research on children and food marketing

To ensure the growth, health and development of children to their full potential, adequate nutrition during infancy and early childhood is essential. The most effective interventions to improve child health is through optimal infant and young child feeding practices. Poor diet will drive malnutrition in early childhood.

Aquatic food, especially aquatic animals, have long been valued as a rich source of animal protein and thus, considered a key constituent of nutritious diets. But the policies on aquatic food tend to focus primarily on production, economic efficiency, resource management. Children under 12 years of age which is the critical age at which interventions have the greatest long term effects for growth and health crona *et al.* and

HLPE records that fish and other aquatic foods are gaining attention for their potential to efficiently provide two fundamental components of sustainable, nutritious food system.

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TYPE 2 DIABETES: CAUSES, COMPLICATIONS AND PREVENTION

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Introduction:

When blood glucose, sometimes referred to as blood sugar, is too high, diabetes develops.

Random blood sugar test: A blood sample will be taken at a random time. No matter when you last ate, a blood sugar level of 200 milligrams per deciliter (mg/dL) or higher suggests diabetes.

Fasting blood sugar test: A blood sample will be taken after you haven't eaten anything the night before (fast). A fasting blood sugar level less than 100 mg/dL is normal. A fasting blood sugar level from 100 to 125 mg/dL is considered prediabetes. If the blood sugar level is 126 mg/dL or above, then the person is with diabetes].

The body uses glucose as its main energy source. Although glucose can be produced by the body, it also comes from the food you eat. The pancreas produces the hormone insulin, which aids in the transport of glucose into your cells for use as an energy source. If a person has diabetes, their body either doesn't produce any insulin at all or uses it improperly. Thus, glucose does not enter cells and remains in the circulation.

Diabetes increases the risk of harm to the heart, kidneys, nerves, eyes, and kidney function. Some cancers have been linked to diabetes. Your chance of acquiring diabetes-related health issues may be reduced by taking measures to avoid or control diabetes

Different types of diabetes

The most common types of diabetes are type 1, type 2, and gestational diabetes.

Type 1 diabetes

A person with type 1 diabetes has little to no insulin production. Insulin-producing cells in the pancreas are attacked and destroyed by the immune system. Although it can develop at any age, type 1 diabetes is typically diagnosed in children and young people. To stay alive, people with type 1 diabetes must take insulin every day.

Type 2 diabetes

The body's cells improperly utilise insulin in type 2 diabetes. Although the pancreas may produce some insulin, it does not produce enough to keep your blood glucose levels within the usual range. The most prevalent type of diabetes is type 2. Anyone who has risk factors for the disease, such as being overweight or obese and having a family history of the condition, is more likely to acquire type 2 diabetes. Type 2 diabetes can strike anyone at any age, even children.

Knowing the risk factors and making changes to a healthier lifestyle, such as decreasing weight or preventing weight gain, can help one delay or prevent type 2 diabetes.

Gestational diabetes

A form of diabetes known as gestational diabetes appears during pregnancy. After the baby is born, this type of diabetes typically disappears. However, if you had gestational diabetes, your risk of getting type 2 diabetes in the future is increased. Type 2 diabetes can sometimes be detected during pregnancy.

Prediabetes

Blood glucose levels in those with prediabetes are higher than average but not high enough to be classified as type 2 diabetes. You run an increased risk of getting type 2 diabetes if you currently have prediabetes. Compared to persons with normal glucose levels, you also have an increased chance of developing heart disease.

Other types of diabetes

Monogenic diabetes is a less common kind of diabetes that results from a single gene mutation. Diabetes can also be brought on by pancreas removal surgery or pancreas damage from conditions like cystic fibrosis and pancreatitis.

Symptoms

Type 2 diabetes symptoms frequently appear gradually. In fact, you may have type 2 diabetes for years without realizing it. When symptoms do exist, they may consist of:

- Increased thirst
- Frequent urination
- Increased hunger
- Unintended weight loss
- Fatigue
- Blurred vision
- Slow-healing sores

- Frequent infections
- Numbness or tingling in the hands or feet
- Areas of darkened skin, usually in the armpits and neck

Causes

Type 2 diabetes is primarily caused by two issues: the pancreas is unable to produce enough insulin to keep blood sugar levels within a healthy range and cells in the muscle, fat, and liver grow resistant to insulin.

It is unknown why this occurs specifically. Key contributing factors include being overweight and being inactive.

How insulin works

A gland below and beneath the stomach called the pancreas produces the hormone insulin. The following are some ways that insulin regulates how the body consumes sugar:

- Insulin is released by the pancreas in response to blood sugar levels
- Sugar can enter the cells because insulin is circulating in the bloodstream
- Sugar levels in the bloodstream decrease
- The pancreas produces less insulin in response to this decline

The role of glucose

The cells that make up muscles and other tissues primarily get their energy from glucose, a sugar. The following are examples of how glucose is used and controlled. There are two main sources of glucose: the liver and the food. Insulin helps glucose enter cells after it is absorbed into the bloodstream. The liver stores and makes glucose. The liver converts stored glycogen into glucose when glucose levels are low to maintain a healthy blood sugar level.

This procedure is ineffective in type 2 diabetes. Sugar builds up in the blood rather than moving into the cells. The pancreas releases more insulin as blood sugar rises. At last the cells in the pancreas that cause insulin to become harmed and can't make sufficient insulin to address the body's issues.

Risk factors

The following factors may raise the likelihood of developing type 2 diabetes:

Weight: A major risk is being overweight or obese.

Fat distribution: A higher risk is associated with storing fat primarily in the abdomen rather than the hips and thighs. Men with a waist circumference greater than 40 inches and

women with a waist circumference greater than 35 inches are more likely to develop type 2 diabetes.

Inactivity: The risk is higher for people who are less active. Active work assists control with weighting, goes through glucose as energy and makes cells more delicate to insulin.

Family ancestry: A singular's gamble of type 2 diabetes increments on the off chance that parent or kin has type 2 diabetes.

Race and ethnicity: Black, Hispanic, Native American, Asian, and Pacific Islander people, among other races and ethnicities, have a higher risk of developing type 2 diabetes than white people do. The reason for this difference is unknown.

Blood lipid levels: Low levels of high-density lipoprotein (HDL) cholesterol, also known as the "good" cholesterol, and high levels of triglycerides are linked to an increased risk.

Age: The risk of developing type 2 diabetes goes up with age, particularly after the age of 35.

Prediabetes: Prediabetes is a condition where the glucose level is higher than typical, yet not sufficiently high to be delegated diabetes. Prediabetes frequently progresses to type 2 diabetes if left untreated.

Risks associated with pregnancy: People who were diagnosed with gestational diabetes while pregnant and who gave birth to a child weighing more than 9 pounds (4 kilograms) are more likely to develop type 2 diabetes.

Polycystic ovary disorder: Having polycystic ovary condition, a condition described by unpredictable feminine periods, overabundance hair development and corpulence, expands the gamble of diabetes.

Complications

Numerous major organs, including the heart, blood vessels, nerves, eyes, and kidneys, are affected by type 2 diabetes. Likewise, factors that increment the gamble of diabetes are risk factors for other serious infections. Overseeing diabetes and controlling glucose can bring down the gamble for these difficulties and other ailments, including:

Heart and vein infection: Diabetes is linked to an increased risk of heart disease, stroke, high blood pressure, and atherosclerosis, a condition in which blood vessels narrow.

Damage to the limbs nerves: The term for this condition is neuropathy. High glucose after some time can harm or obliterate nerves. That could cause tingling, numbness, burning, pain, or eventual loss of sensation, which typically starts at the tips of the toes or fingers and gradually spreads upward.

Other nerve harm: Heart rhythms that are off can be caused by heart nerve damage. Nausea, vomiting, diarrhea, and constipation are all symptoms of digestive system nerve damage. Erectile dysfunction may also be brought on by nerve damage.

Kidney illness: Diabetes may result in irreversible end-stage kidney disease or chronic kidney disease. That might necessitate kidney transplant or dialysis.

Eye harm: Diabetes builds the gamble of serious eye infections, like waterfalls and glaucoma, and may harm the veins of the retina, possibly prompting visual deficiency.

Skin problems: Certain skin conditions, including bacterial and fungal infections, may be more likely to occur in diabetics.

Slow recovery: Blisters and cuts that go untreated can lead to serious infections and poor healing. Toe, foot, or leg amputation might be necessary for severe damage.

Hearing debilitation: Diabetes patients are more likely to suffer from hearing issues.

Sleep apnea: Type 2 diabetics commonly suffer from obstructive sleep apnea. Both conditions may be primarily caused by obesity.

Dementia: Type 2 diabetes appears to build the gamble of Alzheimer's infection and different issues that cause dementia. Memory loss and other cognitive decline are linked to poor blood sugar control.

Prevention

Making choices for a healthy lifestyle can help prevent type 2 diabetes. Changes in your lifestyle may slow or stop the progression to diabetes if you have been diagnosed with prediabetes.

Included in a healthy lifestyle are:

Eating quality food varieties: Pick food varieties lower in fat and calories and higher in fiber. Concentrate on whole grains, vegetables, and fruits.

Getting dynamic: Aim for 150 minutes or more per week of moderate-to-vigorous aerobic exercise, such as swimming, biking, walking, or cycling.

Getting thinner: On the off chance that you are overweight, losing an unobtrusive measure of weight and keeping it off may postpone the movement from prediabetes to type 2 diabetes. Losing 7% to 10% of your body weight may lower your risk of developing diabetes if you have prediabetes.

Avoiding prolonged periods of idleness: Standing by for significant stretches of time can build the gamble of type 2 diabetes. Try to get up and move around for at least a few minutes every thirty minutes.

Metformin (Fortamet, Glumetza, and other diabetes medications) may be prescribed to prediabetes patients to lower their risk of type 2 diabetes. This is usually given to older people who are obese and can't change their lifestyle to lower their blood sugar levels.

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RESEARCH TRENDS IN NUTRITION SCIENCE

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Abstract:

Nutrition sciences have a long history of dealing with food and nutritional requirements for diverse populations, reducing the inherent complexity into reasonable suggestions in the form of dietary counselling for the aim of disease prevention. Nutrition is a dynamic field. As technology advances, research in our field has enabled us to analyse more thoroughly the influence of diet on our health, physically, psychologically, and even external to our bodies. Malnutrition can be primary, arising from a deficiency of one or more vital nutrients, or secondary, resulting from an error in metabolism, interaction between nutrients, or interaction between nutrients and drugs used in therapy.

Keywords: Metabolism, Malnutrition, Technology, Sustainable Nutrition & Heterogeneity

Introduction:

FOOD has always been an important part of our lives. We have acquired a wealth of data on the use of food to ensure the development of children and teenagers, to maintain good health throughout life, to meet the unique needs of pregnancy and nursing, and to recover from illness. The study of nutrition involves the exploration of what supplements we truly desire, the quantity we desire, why we desire them, and where we could obtain them. Sustenance is the outcome of the body's feasts and how the body uses the food given. Nutrition is a dynamic field. As technology advances, research in our field has enabled us to analyse more thoroughly the influence of diet on our health, physically, psychologically, and even external to our bodies. Specialists may learn about the effects and repercussions of certain nutritional therapies, how to manage or cure chronic disease, and how to avoid unfavourable health.

Malnutrition can be primary, arising from a deficiency of one or more vital nutrients, or secondary, resulting from an error in metabolism, interaction between nutrients, or interaction between nutrients and drugs used in therapy.

Nutrition science

Nutritional Sciences is the study of food, nutrients, and other dietary elements, their consumption and biochemical processing, their relationship to health and sickness, and the application of this information to policy and programmes. It has a wide range of uses. Nutritional scientists research how food is digested, absorbed, and metabolised at various stages of life, as well as the effects of nutritional deficiencies and excesses on sickness prevention and treatment. Nutritional scientists also employ information from the social sciences to investigate the socio-cultural, psychological, economic, and political factors that impact food choice and health statistics.

The field's foci range from biochemical process research and genetic connections to population intake and relationships to designing and testing nutrition interventions to improve community health, to managing nutrition programmes and policies to ensure access to nutritious food, among other things.

History of modern nutrition science

Historical summaries of nutrition research have been prepared, focusing on dietary counselling, general scientific advances, or specialised nutritional treatments.1234 "You must understand the past to understand the present," Carl Sagan said, and Martin Luther King, Jr. added, "We are not makers of history; history shapes us."

New study objectives in nutrition science are emerging, based on evidence on the numerous effects of various foods, processing processes, and eating behaviours. The Health Assembly approved the 13th General Programme of Work (GPW13) in May 2018, which will guide WHO's activities from 2019 through 2023. Reduced salt/sodium intake and elimination of industrially produced trans-fats from the food supply are highlighted in GPW13 as part of WHO's priority measures to achieve the goals of ensuring healthy lifestyles and promoting well-being for people of all ages.

Reserch trends in nutrition science

1. Climate: friendly and sustainable nutrition
2. Plant based nutrition
3. Digital nutrition therapy
4. Personalized nutrition
5. Nutrition for the gut
6. Awareness for healthy eating

7. Mindful eating
8. Vegan diet
9. Alcohol free drinks

1. Climate-friendly and sustainable nutrition

The top nutrition trend for 2023 is the same as it was in 2022: eating ethically and in a climate-friendly manner, which includes eating less meat and purchasing foods that are locally and seasonally available. Furthermore, reducing food waste and packaging are ongoing concerns in the zero-waste movement.

2. Plant-based nutrition

The shift from animal to plant-based diets is closely related to sustainability. While your grandparents and parents may have eaten meat on a daily basis, veggies are increasingly taking the lead in the kitchen. Vegan or vegetarian may be too radical for some foodies, but a rising number of people identify as flexitarian.

3. Digital nutrition therapy

The pandemic has introduced technology into almost every industry. Nutrition is no exception. Aside from eating apps, digital nutritional consulting has risen substantially in recent years. Online coaching is popular among the "Silver Generation" (those aged 50 to 70) since it is convenient in terms of time and location.

4. Personalized nutrition

Most people have realised that there is no such thing as a "perfect diet" for everyone. What we (should) consume changes depending to our body type, activity level, and other circumstances, just as our eating times alter. The major drivers for personalised nutrition are so-called 'Functional Foods' in combination with digital products.

5. Nutrition for the gut

The impact of our microbiota on our brains is one of the most popular scientific topics right now. Our stomach has an influence not just on our health and well-being, but also on our athletic performance. As a result, shoppers are increasingly purchasing microbiome-healthy foods, particularly fermented goods. If you want to learn more about this subject, read "Gut" by Giulia Enders.

6. Awareness for healthy eating

Aside from how to make our meals more sustainable and environmentally friendly, people are actively looking for ideas (such as intermittent fasting) on how to lose weight and which foods and nutritious recipes could aid them on their health journey.

7. Mindful eating

People used to associate good eating with boundaries and restrictions. Nowadays, the emphasis is on creating a long-term, comfortable relationship with food. This includes making time to prepare and enjoy meals, as well as paying attention to your body's cues.

8. Vegan diet

While animal-free items are taking over our supermarket shelves, restaurants are getting more imaginative with plant-based meals. There is an animal-free version of every recipe.

9. Alcohol-free drinks

The temptation to drink alcohol at social occasions has decreased. Not just among the young, but also among the old. Following the popularity of alcohol-free beers, non-alcoholic wines are entering the market. Aside from the food industry, businesses and municipalities are developing beverages that provide enjoyment while avoiding the negative repercussions of alcohol.

Mega-trend: Sustainable nutrition

Sustainable nutrition, or providing food that is mindful of people's, the planet's, and society's health, has become increasingly important to include into all we do in recent years. We are all accountable for finding solutions. Thinking about the four aspects of sustainable nutrition described below in combination is one way to make progress towards a more sustainable food supply.

Functionality flourishing

There has been a spike in items aimed at supporting consumers in proactive health management, particularly those concentrating on certain demand states (e.g., energy, immunity). This is especially true for beverages, which were formerly solely available as supplements such as capsules and are now widely available in a variety of beverage formats. At the centre of this trend is the development of functional chemicals with the goal of providing those health benefits. Scientific research proving a true health benefit, as well as safety studies for regulatory compliance, are required. Improvements in usability are also a goal in the transition from supplements to beverages. Soluble compounds with few off-notes and a neutral flavour, as well as cost-effective doses, will be useful to organisations looking to cut expenses by including functional components.

Women's health

Women's health refers to the physiological and nutritional needs of females at various stages of their life (adolescence, reproductive age, pregnancy, lactation, perimenopause, menopause, and post-menopause). Each of these female life stages

requires specialised dietary guidance to support overall well-being. Adolescent girls, for example, have a greater calcium need to sustain lifetime bone density. A calcium deficiency at this age may increase the risk of osteoporosis following menopause, when estrogen's protective effects decline. Understanding the particular nutritional requirements at each female life stage has gained in popularity among women, who are increasingly using technology to track food, menstrual cycle, and lifestyle data.

It is vital that we enhance our understanding of physiological differences between sexes and determine how nutrition might boost women's health, quality of life, sleep, and exercise performance. Females' microbiomes and gut motility differ from men, which may have a role in digestive issues. As we move towards the era of precision nutrition research, using big data to explore gender differences will optimise nutritional interventions to improve health. With groundbreaking product launches in supplements for pregnancy, nursing, infertility, yeast & UTIs, menopause, pre-menstrual cycle symptoms, breastfeeding, stress/sleeplessness, heart health, immunity, and digestive health, the emphasis on addressing female-specific nutritional needs continues to grow.

Advanced activity

The physical activity and healthy ageing industry is expanding to place a greater emphasis on inflammation's influence on joint and cardiovascular function, rather than merely muscle health. This trend has gone not just beyond muscle health to cardiovascular health, joint health, and vitality, but also to all adult age groups. Joint health and cardiovascular health are no longer just about sickness prevention as we become older. Gym-goers seek to increase the function of their joints, heart, and vascular system in order to have more mobility, more effective activities, and better health. Injury risk has been decreased. Advances in our understanding of nutrition's function in vascular health via the nitric oxide pathway, as well as a more in-depth understanding of the many components of joint health, have sparked a spark in research for advanced exercise.

Cognitive health

Cognitive health relates to our ability to focus, complete mental tasks, retain a healthy memory, and manage our emotions. The enormous changes in everyday life over the last few years have resulted in a greater emphasis on mental well-being. Hybrid work schedules may result in additional distractions for some people who work from home, or feelings of loneliness for those who prefer to work in an office. With growing understanding of ingredients such as adaptogens and nootropics and their role in brain health, cognitive health is rapidly acquiring a solid footing in the food and beverage business, and we believe it will only become stronger. As a result, there is increased

interest in dietary therapies that modify the biological response to stress in order to promote sleep, attention, wellbeing, and cognitive performance as we age.

High stakes for sugar and salt

- **Sugar or salt taxes:** More countries are levying fees on sugar-sweetened beverages, high-sugar foods, or high-salt meals. In December 22, the World Health Organisation asked additional countries to levy taxes on sugar-sweetened drinks.
- **Legislation**: In addition to taxes, countries such as Brazil, Mexico, Singapore, and the United Kingdom continue to implement new legislation putting limits or penalties on foods and drinks high in saturated fat, sugar, or salt (HFSS). A recent rule in the United Kingdom prohibits HFSS food advertising and pricing promotions.
- **Front-of-pack labelling:** Labels that penalise foods on the front of the pack for high sugar or salt content, such as the Traffic Light system in the United Kingdom or the Nutri-Score in countries such as France or Germany, are becoming increasingly widespread. Food and beverage releases with a controlled nutrition warning label have grown by 69% year on year (Innova trends).
- **Ultra-processed food criticism/vilification**: Governments continue to scrutinise ultra-processed foods (UPFs) when analysing and proposing nutrition policies. There is a heated scientific debate about UPFs, with some groups claiming that eating ultra-processed foods is associated with poorer health outcomes, while others argue that there is no clear cause-and-effect relationship and that UPFs play an important role in ensuring a sustainable food supply due to factors such as long shelf life.

Protein production's future

Given the enormous task of feeding a population of 10 billion people on one planet by 2050, food science and technology will play a critical role in the coming years. Alternative protein-creation processes are rapidly advancing, and science holds the key to our planet's future.

In recent years, innovation has drastically decreased the average cost of making a cultured beef patty, from $1 million per kg in 2000 to around $100 per kg in 2020 (Rethinkx - Rethinking Food and Agriculture). It is predicted to reduce to less than $10 per kilogramme by 2025, making it cost comparable with regular beef.

Microbiome: beyond digestive health

Our microbiome's bacteria play an important part in our health, and they don't just exist in our gut or digestive tract. They can communicate with bodily systems in which they are not actively alive, such as our brain or immune system, and exist on our skin, in our mouth, and in many other locations. As a result, while most people associate the term

"microbiome" with digestive or gut health, its impacts extend well beyond our digestive system. These impacts can be seen in areas of health such as mood, dental health, and even exercise.

Hydration optimised

Hydration has moved from water or traditional sports drinks to a varied range of electrolyte powders, oral rehydration treatments, and products that make drinking water more fun, such as flavoured sparkling water. Although most of us are not severely dehydrated, many people find it difficult to drink enough water every day, and even mild dehydration can have an impact on things like mood and cognition. Athletes and anybody who engages in a lot of physical exercise usually experiment with hydration solutions other than water.

Affordable nutrition

One method for focusing on low-cost nutrition is to look at the nutrients given per price of a product. Although many measurements examine the cost per calorie, food is considerably more than that. Fibre, protein, vitamins, minerals, and polyphenols are all important for life, and nutritious meals may be misrepresented when just cost per calorie is evaluated. Some foods give sustenance in a disproportionately efficient manner. A Nutrient-Rich Foods Index with pricing data and showed that fruits, vegetables, beans, and eggs are some of the most cost-effective sources of nutrition.

The impact of nutrition science on past, present, and future human health

Food, nutrition, and health are all highly impacted by biological, environmental, social, cultural, and behavioural factors. Because nutritional demands alter with age, gender, weight, heredity, amount of activity, physiological and medical status, nutrition can have an impact on an individual from conception through adulthood1. The continued global population increase, as well as climate change and unequal access to nutritious meals, add to the complexity.

To make further progress, research will need revolutionary thought and action. Stronger cross-sector and cross-disciplinary collaborations will be required to guarantee that the research base is best positioned to address the main global nutrition research concerns. It is therefore appropriate to take stock and determine how nutrition science should proceed.

Impact of nutrition science to human health

Past perspectives and future directions hosted by the Nutrition Society Irish Section. The Irish Section 2022 Conference of the Nutrition Society highlighted the importance of nutrition science to human health, from historical perspectives to future directions.

Recognizing earlier nutrition successes, a global panel of experts will assemble to address current issues and the future of nutrition science.

Challenges and opportunities for better nutrition science

Nutrition science is the only scientific area in which self-proclaimed "experts" have such a tremendous influence. This is most likely due to the media's excessive focus on nutrition and the fact that food is a part of everyone's daily life. Any new nutrition research, regardless of size or quality, garners unparalleled public interest.

Power of "big food"

The food and beverage sector has developed from mid-sized businesses in the 1970s to multinational giants with great power, money, and influence today. The top 10 companies control more than 70% of what we eat and drink and have annual sales that exceed the GDP of numerous countries. The medical profession has learned the painful lessons of influence from the cigarette and pharmaceutical businesses, but it has yet to adequately recognise the power of food and beverage firms, which have a considerably bigger impact on human health.

Funding

When compared to other fields such as HIV or cancer, global funding for obesity and nutrition research is insignificant. Pharmaceutical companies spend over a billion dollars on average to bring pharmaceuticals to market with no benefits over competition. Governments and health authorities, as well as philanthropic individuals and organizations, must reassess their funding priorities in order to promote better investigations. For years, food companies have maintained that they lack the means to do appropriate long-term study on the health and safety of their products, but this is no longer the case.

Study quality

The majority of our dietary information comes from large observational studies that began several decades ago. These have been supplemented by small, short-term human studies of various quality, as well as animal research. These large observational studies offer a high degree of generalizability but are prone to bias. In contrast, short-term, typically reductionist human trials promote rigour while restricting generalizability. We believe this is faulty logic; the power of using both strategies is to maximise the combination of generalizability and rigour. Improved nutrition evaluation methods, on the other hand, would benefit both.

Context and reductionism

Many variations in studies might be ascribed to the environment in which a component or meal is taken, as well as the alternative meals available. Over the last five

decades, there has been debate on the optimal macronutrient ratios (fat, carbohydrates, and protein) that humans should consume. All categories include a variety of healthy and harmful subcategories, as well as many distinct ratios that appear to be healthy. It is believed that the food we eat contains at least 26 000 different species.

Demoting the calorie

We must promptly abandon calorie counting as the foundation of dietary guidance and obesity prevention. There is growing agreement that it is ineffective as a weight-management technique. It is impossible to correctly estimate intake, and too many variables impact calorie expenditure to make calorie tracking practical. According to new human studies, our bodies and metabolic rates might respond differently when given similar calories in different settings. This implies that we require various sustainable public health initiatives that focus on food quality rather than quantity. While portion size and portion management are still issues,

Microbiome

The discovery of the gut microbiota, which is more than a fleeting fad, has been a significant development in nutrition during the last decade. Trillions of microorganisms have 100 times more genes than humans and act like a virtual organ, creating hundreds of compounds, including important metabolites and critical vitamins. Most ingested medications, such as cancer treatment, are altered by gut microorganisms.

Personalized nutrition

Recent large-scale population studies employing artificial intelligence combined with digital technology and the microbiome have clearly revealed substantial heterogeneity in human metabolic response to meals. Fears about 1.5°C global warming and its implications have grown widespread in all countries. The estimated 15-20% of global warming effect connected to food production should not be overlooked, since most of this is possibly adjustable by our eating choices. Current health guidelines favouring daily cow's milk or two to three servings of fish. More positively, tying an individual's behavioural diet change to a national or global environmental aim may boost the likelihood of long-term success by matching personal ideals with external, social challenges.

Education and training

The last pieces of the jigsaw required to achieve progress in nutrition are distribution and education on areas of agreement as well as new issues and solutions. Academic nutrition departments must embrace interdisciplinary techniques to expand the scope and quality of nutrition research and get a better grasp of new subjects.

Governments must recognise that a bigger portion of the financing pie is required for nutrition research, as well as direct independent funding for large trials of eating patterns. The training of doctors and other health professionals, as well as their continuous inability to provide nutritional guidance, is a worldwide shame. In most nations, students spend more time learning about scurvy, which they may never see a case of, than they do about obesity. Many diabetic medical trainees continue to learn little about food and lifestyle interventions while becoming experts on uncommon pharmacological side effects. There are few medically certified experts in nutrition and obesity, hence there are few role models for aspiring physicians.

However, it needs to be seen if we have the flexibility and attitude to adjust to the significant challenges that lie ahead, and whether this can be converted into real dietary change to benefit population health.

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MILLETS: THE NUTRI-CEREALS FOR NUTRITION FOOD

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Abstract:

Millets are drought-resistant and able to survive a variety of environmental conditions. Small-seeded grains rich in proteins, minerals, and bioactive compounds, these grains have several health benefits as well as protection against chronic and degenerative conditions caused by modern living. Millets are popular as functional ingredients for developing novel food products of commercial significance due to their hyperglycaemic profile and bioactive composition. The coarse nature of millets makes them unpopular and underutilized in developed countries, despite their benefits and agro-economic potential. The present article reviews research investigations about nutritional composition (macro- and micro nutrients) of millets.

Keywords: Millets, nutri cereals, nutritional properties

Introduction:

Various types of millets have been reported from the pre-Harappan culture at Rohira, the Late Harappan culture at Hulas in western Uttar Pradesh, in the same context at several sites in Guarajat (Rangpur, Surkodta, Rojdi) and in the Neolithic levels at Hallur (Karnataka), besides Pirak in Pakistan. These grains were grown in the Chalcolitihic culture at Ahar (south-eastern Rajasthan) and at Paunar in northern Maharasthra. The evidence from these sites is as follows Evidence for the cultivation of jowar millet (*Sorghum vulgare* L.) at Rohira has been obtained from Period IA (pre-Harappan, ca. 2300-2000 B.C.) along with that of barley, wheat, lentil and horse gram (IAR, 1983-84:188). The Late Harappan crops at Hulas (district Saharanpur) comprised barley and several varieties of wheat and pulses. A single subglobos seed with vaguely rugose ornamentation was provisionally identified as ragi (Eleusine coracana) (IAR, 1982-83:149).

Government of India had proposed to United Nations for declaring 2023 as International Year of Millets (IYOM). The proposal of India was supported by 72 countries and United Nation's General Assembly (UNGA) declared 2023 as International Year of

Millets on 5 th March, 2021. Now, Government of India has decided to celebrate IYOM, 2023 to make it peoples' movement so that the Indian millets, recipes, value added products are accepted globally.

Millets belong to minor cereals in the grass family Poaceae. Millets are cereal crops grasses with small-seeded structures planted in diverse tropical and desert climates with the capacity to thrive in less rich soil (Shobana *et al.*, 2013). Millets are the world's sixth most important cereal grain, providing nourishment and energy to millions of people in India, Africa, and China, particularly in dry and semiarid areas (Das *et al.*, 2019) They are higher in nutrients than other main grains and are frequently referred to as "Nutri-Cereals" due to their higher nutritional content than commonly manufactured major cereals (FAO, 2018). According to the Indian Council of Agricultural Research and the Indian Institute of Millets Research (ICAR-IIMR), Nutri-cereals are extremely nutritious grains with the same amount of nutrients as frequently eaten cereal foods (Saini *et al.*, 2021). Millets are an essential source of nutrition for millions of people worldwide, notably in hot and dry climates (Amadou *et al.*, 2013). Millets are the world's sixth most important crop, feeding one-third of the global population (Saleh *et al.* 2013). They are annual small-seeded grain crops farmed worldwide for food, feed, fodder, and oil and come in over 20 different varieties (Das *et al.*, 2019). They include Sorghum (*Sorghum bicolor* L.), Pearl millet (*Pennisetum glaucum*), Finger millet (*Eleusine coracana*), Kodo millet (*Paspalum setaceum*), Proso millet (*Penicum miliaceum*), Foxtail millet (*Setaria italic*), Little millet (*Panicum sumatrense*), and Barnyard millet (*Echinochloa species*) (Saleh *et al.*, 2013).Millets are mainly categorized into two categories: Major millets and minor millets. Sorghum, pearl and finger millet or ragi are major millets, while kodo, barnyard, proso, tiny, and foxtail millet are minor millets (Banerjee and Maitra, 2020) . Compared to many other crops, millets can produce much higher yields on minimal soils with low fertility and low input farming techniques and have the potency to be a saviour for the world's increasing population, hunger, and food shortages (Das *et al.*, 2019).

Nutritional composition

Carbohydrate

Carbohydrates are necessary for all living things in our environment to survive. Humans rely on them as their major source of energy. Millets have a carbohydrate content ranging from 50 to 88 percent, depending on the type, species, agro-climatic conditions, and crop management. They also have dietary fibre in the form of arabinoxylans, cellulose,

hemicellulose, lignin, and b-glucan (Serna-Saldivar and Espinosa-Ramırez, 2019). Millet carbohydrates contain60- 75% starch, 15-20% non-starchy polysaccharides and 2-3%free sugars (Chauhan *et al.*, 2018). Millets' compositional profile in (Table 1) shows that among millet grains, pearl millet, *kodo* millet and finger millet contain a comparatively higher proportion of starch (Serna-Saldivar and Espinosa Ramırez, 2019). Patil (2016) reported that some varieties of finger millet, proso millet and foxtail millet are glutinous owing to their waxy starches. Millet starches have been characterised as pentagonal, polygonal, spherical and round granules of diverse sizes with certain pores at the surface (Annor*et al.*, 2014; Zhu, 2014). When compared to other millets, barnyard millet contains the greatest percentage of crude fibre and dietary fibre, with 6.1-10.5 percent insoluble and 3.5-4.6 percent soluble dietary fibres (Veena*et al.*, 2005).

The total dietary fibre content of foxtail, proso and *kodo* millets is also high when compared to other cereals. Insoluble dietary fibre components in millet grains include lignin and cellulose, whereas soluble fibre comprise glucoarabinoxylans, beta-glucans, and some hemicellulose, depending on branching and cross-linking. The most significant portion of dietary fibre is an insoluble part which induces antioxidant activity due to the presence of certain poly phenolic compounds, helping in prevention against certain degenerative diseases such as gastrointestinal disorders, cancers and neurological difficulties (Kaur *et al.*, 2014). Higher amount of dietary fibre causes considerable decrease in the gut transit time generate short-chain fatty acids due to colonic fermentation and slow down the release of sugars in the blood (Kaur *et al.*, 2014). Studies have indicated that pearl millet has highest concentration of soluble sugars followed by finger millet and foxtail millet (Chauhan *et al.*, 2018). Furthermore, foxtail millet, pearl millet, and finger millet have been reported to comprise minor fractions of fructose as well (Serna-Saldivar and Espinosa-Ramırez, 2019).

Protein composition and their fractionation in millets

The protein content of millets presents is varied between the species and varieties due to agro-geographical and genetic variability factors. Comparatively, little and proso millet have higher quantity of protein than high protein cereal grain species ranging between 10% and 15%; however, protein content is also significantly affected by agronomic conditions and practices including content and application method and time of nitrogen, and growth environment. Millets are excellent options for developing value-added food items for malnourished and targeted groups due to their high protein content.

Although the quantity of protein holds high significance, Although the quantity of protein is important, the amount of amino acid content of the protein determines the grain's quality potential. Most cereals are low in lysine, although millets, finger millet, and *kodo* millet have 2.2-5.5 g lysine/100 g protein, and pearl millet can have as much as 6.5 g lysine/100 g protein (Bean *et al.*, 2019). Taylor and Taylor (2017) confirmed that the presence of albumin, glutelin, or globulin fractions that are rich in lysine verified the high lysine content of pearl millet and finger millet. High germ-to-endosperm ratio in pearl millet may also contribute to high lysine. A higher concentration of prolamin in foxtail and proso millet has been suggested responsible for lower lysine content, but they are higher in leucine. Albumin and globulin composition of millet proteins have better amino acid composition and protein quality when compared to other cereals.

Lipid composition and distribution

Table 1 shows that lipids are found in comparatively lesser amounts in all millet species. Millet's lower lipid content contributes to its longer shelf life since the majority of the fat in millets is found in the germ section, which is removed during decortication (Shobana *et al.*, 2013). The fat content of millets ranges between 1-6%, and certain varieties may have higher proportions which may also sometimes compromise their shelf stability. Slama *et al.* (2019) reported 5.06 percent total lipid content in pearl millet, with mono- and polyunsaturated fat accounting for 77.22 percent of the oil. They further reported that the extracted oil was high in linoleic acid (47.5%) but low in linolenic acid (2.15 percent). Other millets also have comparable concentration range of linoleic acid (41–71%) and linolenic acid (1.1–4.1%). Millets have a low palmitoleic acid concentration (less than 1%) (Serna-Saldivar and spinosa- Ramırez, 2019). The lone exception is finger millet, which has oleic acid as the main fatty acid, accounting for 47.5 percent of total lipids, followed by palmitic and linoleic acid. (Bora *et al.,* 2019). Serna-Saldivar and Espinosa-Ramırez (2019) further documented that the nonpolar lipid fraction accounts for about 80% of the total fat in millets, with triacylglycerols accounting for more than 80% of this. They further revealed that polar lipids in pearl millet comprise phospholipids (~12%) followed by lycolipids (~3%) including phosphatidylglycerol, acyl-monogalactosyldiacyl glycerol, cerebroside, sterol lycoside, lysophosphatidylcholine, phosphatidylcholine and others.

Mineral profile

Mineral deficiency is concerning since it has a significant influence on metabolic processes and tissue structure, potentially leading to severe and chronic illnesses (Soetan *et al.*, 2010). Although mineral profile of each crop is heavily influenced by soil fertility, climatic circumstances, agronomic techniques, environmental and geographical limits, potassium and phosphorus are the most prevalent minerals in all millets. Calcium, sodium, and magnesium are some of the other key minerals found in millets (Vali Pasha *et al.*, 2018). As shown in Table 2, millets are rich in macro minerals, *viz.*, Ca, P, K, Na, and Mg and constitute good amounts of trace minerals, *viz.*, iron, copper, zinc and manganese. Among the millets, finger millet is the rich source of calcium and manganese while foxtail millet contains the highest amount of phosphorus. Barnyard millet contains the highest amount of potassium, sodium and magnesium compared to other millets. *Kodo* millet is rich in trace minerals including iron and copper than the other millets. Calcium and sodium content are almost similar in all the millets ranging between 0.1 and 0.7 g/kg.

Zinc is highest in little millet followed by proso, barnyard, finger and foxtail millet. Gilani *et al.* (2005) reported that polyphenols found in cereals and legumes have been shown to bind positively charged molecules such as calcium, iron, and zinc, affecting their bioavailability and intestine absorption. Saldivar (2016) stated that most of the phosphorus is in the form of phytate/phytic acid (phosphate group) decreases bioavailability due to presence of polyphenols. Milling of millets reduces the concentration of minerals in the flour; however, their availability can be enhanced by the elimination of antinutrients (Oghbaei and Prakash, 2016). Phytic acid content is reduced by several processing treatments such as germination, fermentation, soaking and enzymatic treatment (phytase) which release the chelated minerals and increase their intestinal absorption (Gupta *et al.,* 2015; Rasane *et al.*, 2015). Several nutritional interventions including bio fortification and enrichment have been implemented to deal with mineral deficiency, and millets have the potential to deliver a sufficient amount of nutrients to overcome malnutrition Vinoth & Ravindhran, 2017.

Vitamins profile

Millets are an important dietary source of vitamin B complex except for B12, which is mostly found in yeast and animal products. Most of the vitamins are concentrated in the bran, pericarp and aleurone layer of millets (Saldivar, 2016). Millets have a thiamin and riboflavin level of 0.25-0.57 mg/100 g and 0.05-0.23 mg/100 g, respectively. Asharani *et al.*

(2010) also reported that tocopherols and tocotrienols are also present in minor fractions. The total tocopherol content in minor millets ranged from 1.2 to 4.1 mg/100 g, with finger millet (3.6 mg/100 g) having the greatest concentration. The presence of carotenes has also been reported in pearl millet flour with a concentration of 5.4 mg/kg (Kumar *et al.*, 2021; Dey *et al.*, 2021; McDonough *et al.*, 2000).

Health Benefits in consuming millets

1. Millet is alkaline and it digests easily.
2. The Hunzas: who live in a remote area of the Himalayan foothills and are known for their excellent health and longevity: enjoy millet as a staple in their diet.
3. Millet will hydrate your colon to keep you from being constipated.
4. Millet acts as a prebiotic feeding micro flora in your inner ecosystem.
5. The serotonin in millet is calming to your moods.
6. Millet is a smart carb with lots of fibres and low simple sugars. Because of this it has a relatively low glycaemic index and has been shown to produce lower blood sugar levels than wheat or rice. (Kamari and Sumathi, 2002)
7. Magnesium in millet can help reduce the effects of migraines and heart attacks.
8. Niacin (vitamin B3) in millet can help lower cholesterol.
9. Millet consumption decreases triglycerides and C-reactive protein. Scientists in Seoul, South Korea concluded that millet may be useful in preventing cardiovascular disease. Nutrition Research. April 2010; 30(4):290-6.
10. All millet varieties show high antioxidant activity. A team of biochemists analyzed the antioxidant activity; all varieties showed high antioxidant activity. Journal of Agricultural and Food Chemistry, 9 June 2010; 58(11):6706-14.
11. Millet is gluten-free and non-allergenic. A great grain for sensitive individuals.
12. Millet‟s high protein content (15 percent) makes is a substantial addition to a vegetarian diet.

Conclusion:

Nutri-cereals have tremendous potential to eradicate the malnutrition from India. It is the need of the hour to promote and popularize the importance of these nutrient rich millets

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MICROBIOLOGICAL VIEW OF BEER PRODUCTION

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What is beer?

Beer is one of the World's oldest prepared beverages, possibly dating back to the early Neolithic or 9000 BC, and it's confirmed record is available in the written history of Ancient Egypt and Mesopotamia. It is the most widely consumed alcoholic beverage and the third most popular drink after water and tea. Global business of brewing industries. The strength of the beer by means of alcohol content is usually around 4 % to 6 % alcohol by volume.

Nutritional information of beer

Table 1: Nutritional information of 1 can of beer (Heineken 330 ml)

Calories	139.0
Fat	0.0 g
Total Carbohydrates	11.0 g
Protein	1.0 g
Fibers	0.0 g
Cholesterol	0.0 g

History of brewing

An accidental occurrence discovered by prehistoric peoples there was first fermented beverage is produced (Hornsey, 2003). Spontaneous fermentation is produced by bacteria, yeast and moulds to take resident in the sugar and carbohydrates rich product. In simple term by decomposing and damaged food, fruits or vegetables allowed to start fermenting by its microbial activities.

Spontaneous fermentation characterized when the sugars and carbohydrates are converted into alcohol and carbon dioxide by "wild" microorganisms that are present in the environment or provided by enzymatical activity (Mussche, 1999). The first evidence of brewing beer was from the Neolithic period (Nelson, 2005). From the confirmation, it is not

known whether grains were used or if other raw materials, such as honey or fruits, provided the sugar and carbohydrate sources. Grain based brewing of beer by means of fermentation process most likely originated in Mesopotamia and Egypt, where grain cultivation first flourished (Meussdoerffer, 2009). Since these early times of brewing of beer, the importance of beer in society and history has been significant. Beer production and consumption has become common and widespread; after water and tea beer is one of the most popular drinks (Nelson, 2005).

Beer production

Beer brewing is art and science which beautifully given by brewery science. The main ingredients in traditional beer production are water, malted barley, hops, and yeast. It is the manipulation of these ingredients, with variations in time and temperature that can determine the creation of tasty or terrible tasting beers. The brewer has a concept of the beer in mind, but must carefully plan and execute the intended brewing process in order to create the expected beer or beer style (Priest and Stewart, 2006). Even with the best laid brewing plans, if the equipment, raw materials, or yeast are microbiologically contaminated or spoilage occur due to the microbial activity, the beer will not meet the brewer's expectations (Bamforth *et al*., 2002). Beer production is a complex process that can be divided into four stages: brewing, fermentation, packaging, and warehousing. Brewing is the first step and includes the grinding of malted barley and mixing the barley with heated water (Priest and Stewart, 2006). The heating of the malt and water releases enzymes that break down the carbohydrates in the malt into simpler sugars, so yeast can utilize these simpler sugars and continue the fermentation process. The resulting liquid or sweetener from the brewing process is called wort. After cooling, the wort is transferred to a vessel to begin the cellaring process. The cellaring process consists of adding yeast to the wort and at this step the fermentation process begins; the yeast metabolizes the sugars in the wort to produce carbon dioxide and alcohol (Priest and Stewart, 2006). After cellaring, the wort is now called beer. When fermentation is complete, the beer and yeast are separated and the beer is allowed to age. The beer at this stage is now considered bright beer which content in bright beer tank and is ready to be packaged. After packaging in bottles, cans, or kegs, the beer will be transferred to a warehouse for storage until it is shipped to various outlets for distribution and consumption (Suzuki, *et al* 2008 & Eliabeth *et al*., 2008).

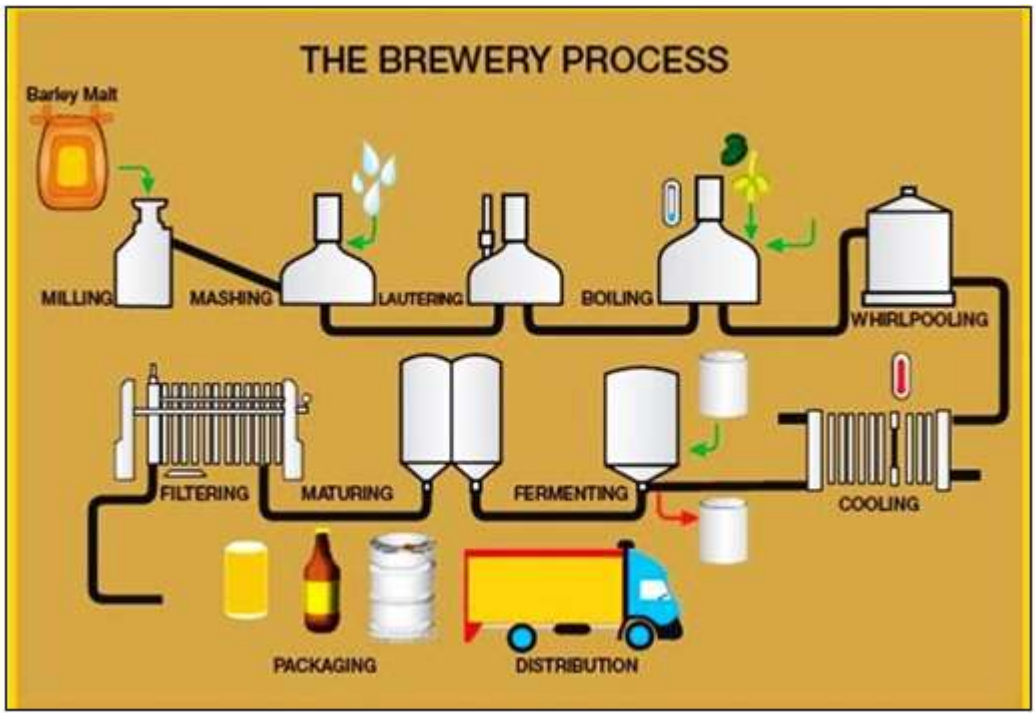

Figure 1: Major processes in brewery

(*https://thesciencenotes.com/brewing-beer-making-process*)

Brewing microbiology

Microbiologically in brewing process, wort and beer have different characteristics that can create either a favourable or unfavourable environment for microorganisms. Oxygenated wort has a pH of approximately 5, is high in carbohydrates, and contains some available protein which makes it an ideal environment for the growth of yeast and bacteria (Menz *et al*., 2010). Beer on the other hand, has a lower pH (~3.8 – 4.3), contains ethanol, hop bitter compounds, carbon dioxide, and has larger, more complex forms of carbohydrates and proteins to break down to give little nutritive substances (Sakamoto and Konings, 2003). The poor nutrient status of beer, low pH, antiseptic action of hops, together with ethanol, restricts the range of bacteria that can grow in finished beers (Priest and Campbell, 2003). Beer also is mostly anaerobic which generally favours the growth of microaerophilic and anaerobic organisms.

Beer production utilizes beneficial microorganisms which is extremely superior for the beer production by means of fermentation process. The most beneficial organism is yeast used for the fermentation of wort (Bamforth *et al.,* 2002). Yeasts are beneficial because they are widely used for production of beer, wine, spirits, foods, and a variety of biochemicals before analysing all important factors like yeast cell count, volume, viability and consistency etc. (Stewart and Russell, 1998).

There are two main types of yeast for most beers brewed worldwide, ale yeast (Saccharomyces cerevisiae) and lager yeast (*Saccharomyces carlsbergensis*); there are hundreds of subspecies of these two types of yeast (Priest and Campbell *et al.,* 2003). In the presence of oxygen, the yeast take up the dissolved sugars, nutrients, and free amino nitrogen in the wort to support growth and proliferation (Stewart and Russell, 1998). Under anaerobic fermentation conditions, the yeast generate several end products: ethanol and carbon dioxide, as well as other volatile and non-volatile compounds. In some sour and wood aged beers, there are other types of wild yeasts (i.e., *Brettanomyces bruxellensis*) and bacteria (i.e., *Lactobacillus spp*.) used in the production to produce the sour and/or spicy notes (Spitaels *et al*., 2015 & Steensels *et al*., 2015).

Culture media for brewing microbiology

The original medium for brewery microbiology was the brewery's own wort, solidified with agar if necessary. The advantage of using a medium with the inhibitory effect of hops is that only potential beer contaminants can grow, but the medium is much richer than necessary for laboratory purposes and varying from brewery to brewery, prevents standardized culture methods. Modern Malt Extract (ME) broth, available commercially in dehydrated form, is much weaker than worth but yet of sufficient nutrient content for all yeast and most brewery bacteria and is widely used. Media with its constant composition consistency was one advantage of the introduction (Priest & Campbell, 2003).

Unfortunately, there is no single medium that suppresses brewing yeast but allows the growth of all possible contaminants. Commonly used selective media for culture and isolation of brewery contaminants.

To visible colonies and second, that *Saccharomyces spp*., biochemically adapted to grow well in brewery and distillery fermentations, are potentially the most common contaminants of these situations but cannot be detected (Suzuki *et al.,* 2008b).

Spoilage microorganisms

Food and beverage processors need to pay careful attention to monitoring the microbial environment within their facilities to prevent the contamination of their product. There are several types of microorganisms that can cause the spoilage of beer. One of the most important parts of the brewing process is the proper control of unwanted microorganisms (Stewart and Russell, 1998).

Most of the microorganisms of concern to the brewer will cause off-flavours or turbidity in the beer; these are beer quality related problems (Sakamoto and Koning's,

2003). The Gram positive lactic acid bacteria are the group of bacteria likely to cause a significant threat to beer (Priest and Campbell, 2003). The two main lactic acid spoilage microorganisms in beer, *Lactobacillus spp.* and *Pediococcus spp.*, are able to survive in beer because they are both facultative anaerobes. These spoilage bacteria are considered the most hazardous. In Germany between 1980 and 1990, 58-88% of microbial beer-spoilage incidents were caused by *Lactobacilli* and *Pediococci* (Back, 1994).

Lactobacillus and *Pediococcus* are Gram positive organisms. *Lactobacillus* can cause a silky turbidity with some lactic acid sourness and/or diacetyl (buttery) off flavour (Priest and Campbell, 2003). *Pediococcus* can cause ropiness turbidity with off-flavours of lactic acid (sourness) and diacetyl (Priest and Campbell, 2003).

Acetic acid bacteria and Enterobacteriaceae spp. are Gram negative beer spoiling bacteria. Acetic acid bacteria oxidize ethanol into acetic acid resulting in producing sour off flavours and turbidity issues. Acetic acid bacteria are aerobes so spoilage of beer should be minimal since beer should be stored with limited access to air (Priest *et al.,* 2002; Stewart *et al.,* 2006). The Enterobacteria are facultative naerobic bacteria. Enterobacteria can produce dimethyl sulphide (DMS) which imparts a parsnip like, sulfury flavour to beer (Boulton *et al.,* 2000; Quain *et al.,* 2001).

Brewers need to be concerned about wild yeasts in the brewery. Wild yeasts can come from raw materials, cross-contamination within the brewery, or the air. Wild yeasts can cause problems for beer quality, causing turbidity, creating phenolic or spicy off flavours, and out competing or killing beneficial production yeasts (Priest and Campbell, 2003).

Yeast propagation

The quality based high level of beer production in breweries is related to different types of yeast culture. Purity and type of yeast affects rate of multiplication, fermentation, haze and aroma of beer (Iorizzo *et al.,* 2021). Yeast microbiology is studied for the cultivation of pure culture of Saccharomyces cerevisiae.

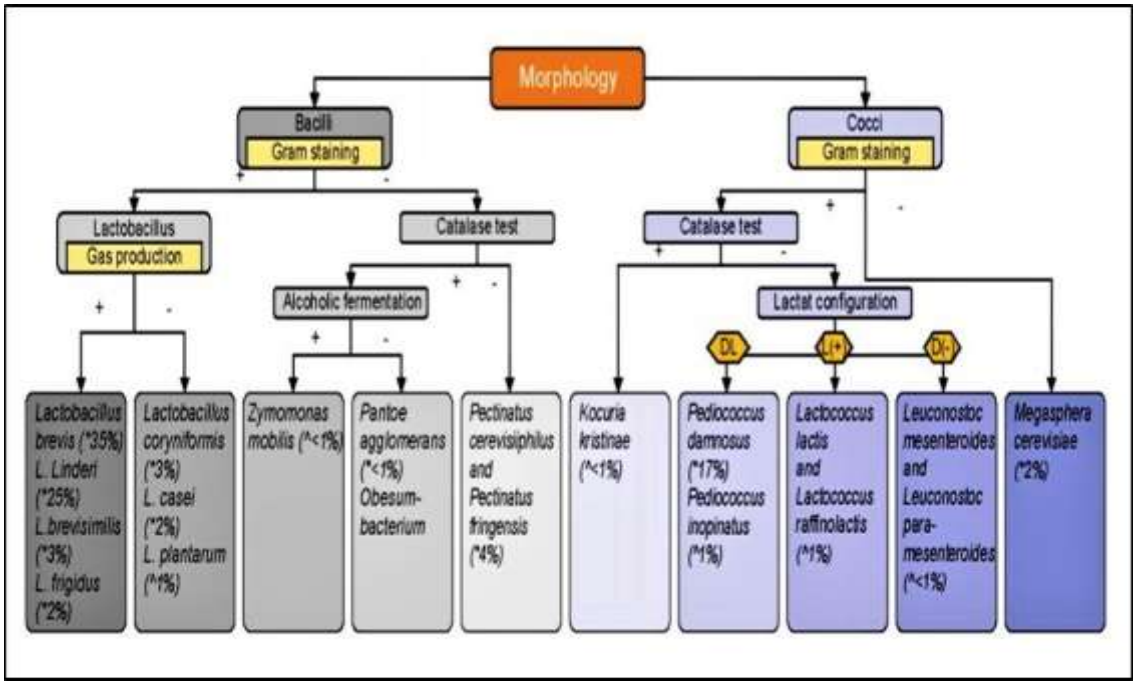

Figure 2: Identification flowchart for beer spoilage bacteria

(*www.sigmaaldrich.com: Siegrist*)

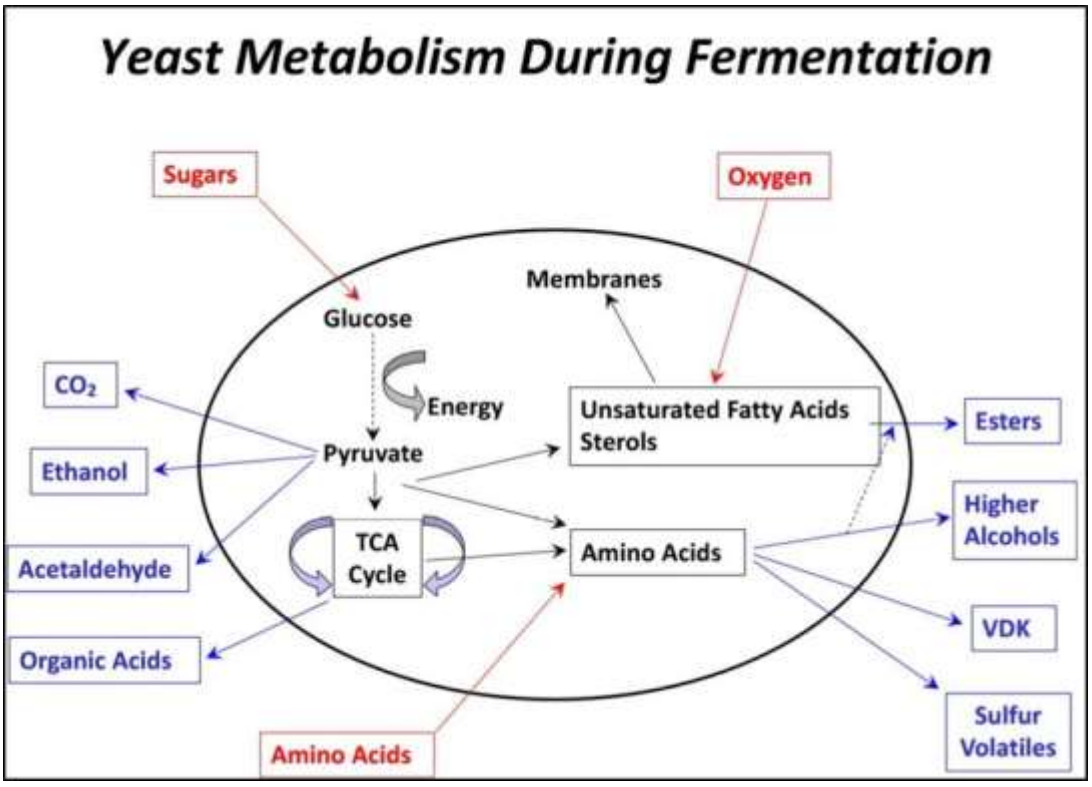

Figure 3: Biochemical pathway of Beer production

(*The Biology of Lager Yeast - ppt download (slideplayer.com)*)

Single cell of a yeast is selected and use to propagate a pure strain. For propagation and cultivation process we have used Carsberg flask and pure yeast culture which is further

incubated with sterile cool wort . Microbiologicl and yeast multiplication analysis characterized in propagation vessels with well equipped heating and cooling coils for sterilization and cooling the wort for good aroma and good beer characteristics (Priest and Campbell, 2003)

Plate 1 (a): Yeast propagation in propagating vessels

Plate 1 (b): Yeast pitching vessels towards cool wort

Food safety

Pathogenic bacteria in food have been linked to numerous foodborne illness outbreaks. In 2011 the annual estimate of disease due to contaminated food consumed in the United States was calculated to be 47.8 million illnesses, 127,839 hospitalizations, and 3,037 deaths (Scallan *et al.,* 2011). Several antimicrobial intrinsic and extrinsic hurdles occur during fermentation including production of ethanol and carbon dioxide, lowered pH and nutrient levels, hop additions, and pasteurization that make beer a hostile environment for the growth of pathogens (Menz *et al.,* 2010). While pathogenic bacteria typically are not a concern to brewers, there are other microbes that need to be monitored for quality purposes (Boulton and Quain, 2001).

Good quality assurance procedures are necessary for ensuring a high level of cleanliness, especially when there is no sterile filtration of beer or bottle/can pasteurization (Henriksson and Haikara, 1991). Sampling for cleanliness and increasing the awareness of hygienic conditions can enable the brewer to produce beer with longer shelf

life, fewer customer complaints, higher production rates, and lower rejection rates (Ligugnana and Fung, 1990).

Hazard Analysis and Critical Control Points (HACCP)

One of the most rigorous and widely accepted preventative programs for the safe production of foods and beverages is known as Hazard Analysis and Critical Control Points (HACCP). HACCP involves implementing a series of preventative measures throughout production to control and limit potential hazards and reduce the risks of foodborne illness in consumers (Barron, 1996). Setting up a HACCP plan comprises seven steps:

Step 1: Conducting the hazard analysis,

Step 2: Determining critical control points (CCPs),

Step 3: Defining critical limits for CCPs,

Step 4: Establishing the monitoring system,

Step 5: Setting up the corrective actions,

Step 6: Verifying the effectiveness of the system, and

Step 7: Documenting all procedures and records (Erzetti *et al.,* 2009).

The intention of HACCP is to produce zero defects; although unattainable, a well-executed HACCP plan does help minimize the number of unsafe products (Kourtis and Arvanitoyannis, 2001).

Potential hazards, or CCPs, can be things that cause harm to the consumer and may be biological, chemical, or physical in nature (Sadeghi, 2010). As risk is being evaluated, hazards that have low or no risk associated with them are identified and often are considered quality control points (Rush, 2006). Quality control points become part of the brewery's quality assurance management program as they are critical to the integrity of the food product (Bamforth, 2002). Many breweries now integrate HACCP and quality assurance management systems to create a holistic approach to assure product safety and quality (Merrill and Francer *et al*., 2000). Although beer is generally safer that other food products because of its intrinsic antimicrobial properties, identification of potential hazards and establishment of preventative and corrective actions is vital (Kourtis and Arvanitoyannis, 2001).

Importance of cleanliness of equipment

Cleanliness of equipment and raw materials is key to the production of beer. The brewer must pay careful attention to the cleanliness of equipment and quality of materials to assure that no beer spoiling organisms are introduced into the product (Priest and

Stewart, 2006). The quality of all food products including beer not only are affected by the integrity of the raw materials, the cleanliness of the equipment, and the packaging materials, but also by the purity of the environmental air surrounding the processing area (Al-Dagal and Fung, 1990).

The presence of undesirable microorganisms can interfere with the process of fermentation by competing with production yeast and producing off-flavours and/or turbidity problems (Bamforth, 2002). If contamination leads to customer complaints and product recalls; the consequences can be very expensive, time consuming, and damage the reputation of the brewer (Priest and Stewart, 2006). Environmental microbial air testing can be used to assess for possible bacterial contaminants. Most breweries use a cleaning in place (CIP) regime to assure that the brewing equipment and cellaring vessels are clean and will not contaminate the finished beer. A properly designed brewery CIP regime consists of a rotation of caustic and acid cleanings followed by thorough rinsing and use of hypochlorite or peracetic acid-based sterilizers (Bamforth, 2002). The CIP regime of closed production equipment is proven to be one of the most efficient and effective ways of limiting spoilage microorganisms and assuring the safety and integrity of food products (Rice, 2011).

Bottling and canning lines in breweries often are considered non-closed production equipment and have the ability to become contaminated from outside sources including the environment (Priest and Stewart, 2006). Microbes are in constant movement in the bottling and canning areas because they settle from the air onto surfaces and then are recirculated into the environment again by the persistent turbulence of the air (Henriksson and Haikara, 1991). In a canning line, the open container is exposed to the environmental air for several seconds or milliseconds, depending on the speed of the canning line, prior to a lid being attached. This environmental air exposure has the potential to lead to final product contamination.

Microbiological analysis of brewery environmental air can be used to determine if there are indicator or beer-spoiling organisms present (Henriksson and Haikara, 1991). The presence of microorganisms in the air can be indicative of poor cleaning of equipment and poor filtering of environmental air (Henriksson and Haikara, 1991).

Trapping the organisms present in the air and growing them on the appropriate media should be important quality control parameters to brewers (Bamforth, 2002). There have been many cases where exposed product has become microbiologically contaminated

due to unfiltered air and negative air pressure in food plant areas (Graham *et al.,* 2011). Many food production facilities and dairies use microbiological environmental air sampling for this purpose (Fung, 2008).

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TRENDS IN FISH NUTRITION: EXPLORING EMERGING CONCEPTS AND RESEARCH

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Abstract:

The field of fish nutrition has witnessed remarkable transformations over the years, driven by advancements in science, technology, and the increasing demand for sustainable protein sources. This article delves into the evolving landscape of fish nutrition, highlighting emerging concepts and research frontiers that are shaping the future of aquaculture and human health. From sustainable feeding practices and functional ingredients to the impacts of climate change and the intricacies of the fish gut microbiome, this exploration provides insights into the dynamic interplay between nutrition, environment, and innovation. By staying attuned to these trends, researchers, practitioners, and policymakers can contribute to the development of efficient and responsible fish production systems that meet the demands of a growing global population.

Keywords: Fish Nutrition, Feed Technology, Emerging Trends

Introduction:

Fish have long been recognized as a valuable source of protein and essential nutrients, contributing significantly to human diets worldwide. The expansion of aquaculture has amplified the importance of understanding fish nutrition, as sustainable practices are crucial to meet the rising demand for fish products (Le Boucher *et al.,* 2012; Pierce and Noakes, 2019). In the ever-evolving landscape of aquaculture and fisheries, the realm of fish nutrition is undergoing a dynamic transformation. As the demand for seafood continues to rise, so does the need for innovative approaches to ensure the health, growth, and sustainability of farmed fish. This has led to the emergence of several key trends that are shaping the way we feed and nurture aquatic species. From alternative protein sources to cutting-edge advancements in precision feeding and genetic understanding, these trends

are not only revolutionizing fish diets but also influencing the broader ecosystem of aquaculture practices (Watanabe, 2002; Tacon and Metian, 2008).

One of the most pressing challenges facing the industry is the quest for sustainable and responsible sourcing of nutrients. Traditionally reliant on fishmeal and fish oil, aquaculture is witnessing a paradigm shift towards alternative protein sources. The pursuit of ecologically friendly options, such as plant-based proteins, single-cell proteins, and even insect meal, is reshaping the composition of fish feeds. This shift not only addresses concerns of overfishing but also sets the stage for a more balanced approach to aquatic nutrition (FAO, 2010). Sustainability is a guiding principle in these changing tides of fish nutrition. With an eye on reducing the environmental footprint, the industry is actively exploring feeds with optimized fish-in, fish-out ratios. The endeavor to strike a balance between resource utilization and production output is driving the adoption of feeds that require fewer wild fish inputs, leading to more efficient and eco-friendly aquaculture operations (Sealey, 2007; Gatlin, 2019).

Yet, the evolution of fish nutrition extends beyond mere ingredient swaps. A revolution in understanding the intricate interplay between genetics and nutrition has given rise to the field of nutrigenomics. This cutting-edge science enables tailored diets that leverage the genetic makeup of fish species, optimizing nutrition to trigger desired gene expressions. This personalized approach holds the potential to unlock new dimensions of growth, health, and disease resistance. Functional feeds, armed with added health benefits, are another hallmark of this transformative era. Probiotics, prebiotics, immune-boosting compounds, and more are finding their way into feeds, enhancing fish vitality and well-being. This holistic approach not only contributes to better fish health but also aligns with the industry's commitment to responsible farming practices.

Moreover, precision feeding is ushering in a new era of efficiency and waste reduction. Harnessing the power of technology, automated feeding systems and sensor-based technologies are ensuring that fish receive precise amounts of nutrition at optimal times. This not only enhances growth rates but also curbs overfeeding, reducing both operational costs and environmental impact (Hamre and Pittman, 2011, Koko and Lovell, 2018).

Sustainable feeding practices

In response to environmental concerns and the finite availability of marine resources, there has been a notable shift towards sustainable fish feeds. Alternative protein

sources, such as plant-based ingredients and single-cell proteins, are being explored to reduce reliance on fishmeal. This trend aims to enhance the ecological footprint of aquaculture while maintaining fish health and nutritional quality (Ng and Koh, 2018; Montero and Izquierdo, 2010).

Precision nutrition

The integration of functional ingredients into fish feeds is gaining momentum. Omega-3 fatty acids, antioxidants, and bioactive peptides contribute to improved fish health and the production of nutrient-rich seafood. The potential health benefits of consuming fish enriched with these compounds extend to human consumers, promoting cardiovascular health and cognitive function (Glencross, 2015; Rønnestad and Yúfera, 2017). Advancements in nutrigenomics have deepened our understanding of how diet interacts with fish genetics to influence growth, disease resistance, and overall performance. Precision nutrition approaches are emerging, tailoring dietary compositions to specific fish species and even individual characteristics. This personalization optimizes feed utilization and reduces waste, contributing to more efficient aquaculture practices (Moyano and Zambonino-Infante, 2001; Pörtner and Farrell, 2008; Rønnestad and Yúfera, 2017). The fish gut microbiome has gained recognition for its pivotal role in nutrient digestion, immune function, and overall health. Manipulating the gut microbiota through nutrition offers opportunities to enhance disease resistance and optimize nutrient absorption, contributing to improved aquaculture productivity (Nayak, 2010; Schmidt *et al.,* 2015).

Plant based aquafeeds

Aquaculture has seen a significant increase in demand due to the growing global population's need for protein. However, the sustainability of aquaculture practices is a concern, particularly regarding the reliance on fishmeal and fish oil, which are limited and ecologically impactful resources. To address these challenges, there has been a considerable shift towards incorporating plant-based proteins in aquafeeds (Montero and Izquierdo, 2010; Benemann, 2013; Newton and Newton, 2013; Hasan and Halwart, 2019; Wu and Kim, 2020; Dawson *at al.,* 2021). Researchers are continually working to optimize plant-based protein inclusion levels, develop processing methods to mitigate antinutritional factors, and improve feed palatability. Genetic selection is also used to develop fish strains that can efficiently utilize plant-based feeds.

Advantages of plant-based proteins

Sustainability: Plant-based proteins offer a sustainable alternative to fishmeal and fish oil, as they reduce the pressure on wild fish stocks and minimize the environmental impact of aquaculture.

Cost-effectiveness: Plant-based ingredients are generally more affordable and readily available compared to marine-based ingredients, making them economically attractive for feed manufacturers.

Reduced fish-in-fish-out ratio: The use of plant-based proteins helps reduce the fish-in-fish-out ratio, which is a measure of the quantity of wild fish used to produce farmed fish.

Challenges and Considerations:

Amino acid profile: Plant-based proteins often have incomplete amino acid profiles compared to fishmeal. This necessitates careful formulation to ensure that essential amino acids are adequately supplied to meet the nutritional needs of the target species.

antinutritional factors: Some plant ingredients contain antinutritional factors, such as phytates and lectins, which can hinder nutrient absorption and affect fish growth. Processing methods are employed to reduce these factors.

Palatability and digestibility: Fish may not find plant-based feeds as palatable as fish-based feeds. Enhancing feed palatability is crucial to ensure fish consumption and growth. The digestibility of plant-based proteins can vary among species and ingredients. This impacts feed utilization and fish growth.

Commonly used plant-based proteins:

Soybean meal: A widely used plant protein source, rich in protein but with some antinutritional factors that require processing.

Canola meal: Provides a good amino acid profile, but its glucosinolate content can negatively impact feed intake and fish growth.

Pea protein: A promising source with balanced amino acid composition and low antinutritional factors. It has gained attention in recent years.

Algae and microalgae: Algae can be cultivated to provide sustainable and high-quality protein sources for aquafeeds.

Future prospectus:

While remarkable progress has been made, there are still gaps in our understanding of fish nutrition. Further research is needed to explore the interactions between nutrition, genetics, and environmental factors. Innovations in feed formulations, biotechnology, and

data analytics hold promise for shaping the future of sustainable fish production and nutritional quality.

Conclusion:

The trends outlined in this article underscore the dynamic nature of fish nutrition research. As the field continues to evolve, interdisciplinary collaboration and the integration of emerging concepts will play a pivotal role in enhancing aquaculture sustainability, improving fish health, and providing nutrient-rich seafood to meet the dietary needs of a growing global population. Staying informed about these trends will be essential for driving meaningful advancements in fish nutrition science. The integration of plant-based proteins in aquafeeds represents a pivotal advancement in sustainable aquaculture. With careful formulation, processing, and consideration of species-specific nutritional requirements, plant-based proteins can contribute to reduced environmental impact, improved feed efficiency, and the overall sustainability of the aquaculture industry.

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