Acta Scientific NUTRITIONAL HEALTH (ISSN:2582-1423)

Volume 7 Issue 9 September 2023

Review Article

Lentil Proteins as an Alternative Source of Proteins

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DOI: 10.31080/ASNH.2023.07.1295

Received: June 29, 2023
Published: August 10, 2023

Abstract

The current challenges of society and the acquisition of the latest knowledge are ready for our revision of food science and technology. Designing a new food product with protein compounds requires careful formulation of food structures, focusing more on producing a combination that is nutritionally dense, with optimized caloric intake and planning, so that it can have benefits beyond simple amino acid intake. Understanding countries' specialized patterns in food production can provide insight into evaluating and designing policies to achieve food security and stability, which is key to achieving sustainable development goals. Therefore, stability in agricultural politics is necessary. Legumes are the main source of plant proteins in human diets in different regions of the world. In addition, lentils play a major role in improving protein malnutrition in developing and underdeveloped countries. Owing to be very nutritious and healthy combination of large amounts and other chemicals in lentils its worldwide, capitation output has increased significantly in recent years. Lentil protein has also been shown to have excellent properties as a gelling agent, emulsifier, and stabilizer, and can be used as a healthy substitute for various animal proteins in various food products. However, further studies are necessary to expand the use of these materials for healthy food compositions. Nevertheless, further research is necessary to expand the use of these substances in nutritious food compositions.

Keywords: Plant Protein; Lentil; Legumes; Functional Proprties

Introduction

Against the rapid population growth in the 20th century, global food science and technology have so far been able to supply adequate food for most people. However, with the prophecy grow in population to at least 9.5 billion by 2050, the availability of arable land is limited; The impact of global climate change on agriculture; Overfishing the oceans and wasting food across the food chain; Even more efforts are needed to prevent a food crisis in the future [1].

It is important to note that all Earth's reserves are inherently limited, and while reclamation is a sensible method, it is certainly incomplete. In the case of biological resorts, it is necessary to identify that their formation is finite by the capacity of photosynthetic organisms to absorb sunlight. Above these basic factors, it is obvious that any stage in the transfer of biological resources to products (from the production of primary biomass to the recycling of natural waste) will certainly have negative effects, such as the release of greenhouse gases or the production of toxic compounds [2].

The Food and Agriculture Organization (FAO) defines food security as all people having physical, social, and economic access to sufficient, safe, and nutritious food that meets their food needs and preferences for an active and healthy life in such a way that all people have access to sufficient safe and nutritious food at all times to maintain a healthy and active life. FAO UNICEF explains food security as a multi-layered theory focused on four majors: Food Availability, Food entrance that includes physical approach and food becomes economical, Food use based on cultural needs and diet, Food sustainability means the stability of its provide [3].

The clarification of sustainability generally expresses features of ecology, economics, and society and has various substances depending on the context. A sustainable diet is not essential described for consumers in the same way that it is defined for farmers or food producers. The FAO described sustainable diets as "low-impact diets that contribute to food and nutrition security and healthy living for present and future generations." Sustainable diets protect and respect biodiversity and ecosystems and are culturally acceptable, accessible, economically impartial, and cost-effective. Adequately nutritionally safe and healthy [4]. Sustainability has various aspects, and food production is an important element. Definitions of sustainable food production generally express aspects of ecology, economics and society in various combinations.

Global foods waste

Changes in the amount of food waste have been reported worldwide. The FAO assesses that around a third of the total each year food manufactured for people depletion in the world is missing or misused. Comparable reports have recorded waste statistics up to 50%. Estimates indicate that food-related activities are due to continued global population growth and per capita income. It creates a large part of the world's environmental pressure [3].

A number of recent studies have shown that between 30% and 50% of the world's food is at no time use and is surely wasted [5]. far, food production by increasing yield per hectare (mainly by increasing irrigation and fertilizer consumption) and protein production level (by intensifying animal production) has been able to keep pace with population growth. Approximately three-quarters of the available fresh water and one-third of ice-free land are used for food production (three-quarters of which is for animal production). In addition, one-third of all transportation is for food [6]. Overall, the range and severity of the effects make it unclear that this level of production can be constant in the latter, when the growing global society and standard of living put even greater force on vital resources, human health, and animal welfare. As an additional problem, biofuels may challenge with food for the equal few land and freshwater resources [7].

More precisely, by 2050, the world is projected to double the demand for animal production by 9.1 billion people that is from 229 to 465 billion kg of meat and from 580 to 1043 billion kg of dairy products [8]. Analyzes show that three of the processes of the Earth system are the rate of loss of biodiversity, disruption of the nitrogen cycle, and climate change previously violated by humans, mostly due to industrial agriculture and the use of fossil fuels [9].

Food systems, including preproduction, production, and post-production activities, add approximately 19–29% of all global anthropogenic greenhouse gas (GHG) ejection [10]. In an attempt to decrease greenhouse gas ejection from food systems, while trying to contact present and future global food inquires, time to decrease greenhouse gas ejection from food systems must be regarded everywhere in the food supply chain. This includes the production methods. This is especially serious because climate change is expected to lead to increased variability in temperature and rainfall, severe weather events, water scarcity, and the prevalence of pests and sickness, all of which have the potential to influence the ability of farming systems to meet future global food needs [11].

According to the results of the last hundred years, the average global temperature has increased owing to uncontrolled emission of greenhouse gases. Due to limited natural resources and the adverse effects of using different energy sources on human health and the atmosphere, reducing greenhouse gas emissions is critical for its effective use in agriculture [12].

The food system accounts for more than 30% of the total ice-free land, 70% of the accessible fresh water and 20% of energy. Sustainable food manufacturing for another 2.3 billion people over the next four decades will require community development and industrial change. Protein supply is very important in terms of food and the environment. Cattle products have an inordinate effect on biodiversity reduction, freshwater reduction, and climate change. The use of organic funds should be decreased using the treatment plant rule and the end circle. The food industry can provide support for the future by producing new plant protein products and modernizing food protection and waste demotion [13].

Nutritional value

Since our ancestors decided to settle, crops and pets have allowed continuous production of food through integrated methods. With the advancement of human civilization, new food supply plans are constantly being discovered, integrated and improved. The main factor in such a process was the need to create flexibility in the face of changing elements of nature that constantly threaten the food supply. Food is important for existence and well-being. Fresh products in the form of fruits and vegetables are considered in terms of vitamins and minerals due to nutrients, and are an essential component in diets suitable for children and adults [14]. Eating nutritious foods can lessen the incidence of disease, lead to undernourishment, and can even continue life.

Research into the role of functional foods, nutrients, and additives in improving people's health has increased. Functional foods provide health benefits beyond essential nutrients such as proteins, carbohydrates, fatty acids, vitamins, and minerals [15].

The food-processing industry has always been stimulated to make processes as efficient as possible to develop production and efficiency, reduce waste, maximize product quality, and help benefits. There is also been an incentive to reduce the strain of such industrial processes in the environment [16].

Proteins

Proteins are essential nutrients in nutrition and are essential for cell growth and restoration mechanisms in the body. The World Health Organization advises 0.75 grams of protein per kilogram of body weight per day for adults. To assess the nutritional quality of a protein, not only is the total protein content of a raw material crucial, but also the digestibility, amino acid characteristics, and presence of an anti-nutrient combination [17].

The main sources of animal protein for people using them include meat, fish, milk, and eggs. Developments in the production of animal protein sources using existing and new protein sources and production methods are directed towards the use of cheaper raw materials, increased health characteristics, and higher stability. For this purpose, the use of new protein sources, waste processing streams, and biofuel production by-products has been considered [18].

Advancing the use of plant proteins is required to create protein-rich foods that can substitute animal proteins in the people regime to lower the pressures that severe animal farming imposes on the environment. Nutritionally, with the right mixture, plant proteins can provide sufficient amino acids for all fitness requirements. In addition to their function as a nutrients, proteins play a major role in food structure through processes such as emulsification, foaming, kneading, and dough formation [19].

In addition, plant proteins that are considered food or surplus nutrients are affected if used. The vital performance characteristics include solubility, hydrophobicity, hydration, binding to water and oil, emulsion, foam, gel, and viscosity. Different yield plates of different plant proteins were credited to accuse delivery, amino acid structure, and molecular size [20].

Animal proteins have high nutritional value because of their combination of amino acids and high digestibility. Animal protein-rich diets are associated with health risks, such as cardiovascular disease, cancer, and increased mortality. In addition, animal protein production has several sources. Consequently, universities and the food industry are looking for alternative proteins [21].

Bean use is associated with potential health benefits, including reduced the risk of cardiovascular disease, cancer, diabetes, osteoporosis, hypertension, gastrointestinal disorders, adrenal gland disease, low LDL cholesterol, and obesity [22].

Mixing animal and plant proteins is a relatively new approach in food science for pursuing synergistic effects. Given the results of over-consumption of animal proteins on supportable evolution, partisan doubling with plant proteins in formulated foods and in foods in raw materials seems to be a viable option. Simultaneously, such options meet the requirements of coming out customer groups that consciously decide to lower their animal protein intake [23].

In addition to problems associated with weak protein changes, increased animal production has other unintended side effects. Consumption of deep energy from meat products is one of the reasons for the prevalence of obesity. Human and animal health includes swine fever, avian influenza, and hormones [24].

Poverty prevents many people from getting enough diet, while economic growth pushes the opposite of meat use up. To meet the growing demand for agricultural goods, there are at the meanest two choices: either to develop and add to agriculture, which now has critical amounts of natural resources, or to switch from consuming high-consumption meat to more plant-based diets [25].

Animal proteins

Throughout human history, meat has been associated with various symbols and rituals. Substitution of protein sources is needed to meet the nutritional needs of the world's growing population. These proteins must be produced using a supportable method with low destructive effects on the environment and economic and agricultural benefits. In addition, the food produced must be useful in counteracting the global rise in chronic disorders (diabetes, cardiovascular disease, obesity, and cancer) and acceptable to both the food industry and consumers [26].

The supply chain of vegetable meat can be divided into explained in four stages. In the first stage, a protein product is produced worldwide. In the second stage, the products are purchased and processed into protein materials such as protein concentrates and isolates [27]. In the third stage, food factories buy protein parts and formulate and convert them into textured intermediates to produce final meat substitutes. Finally, the goods reach customers through retail and food services [28].

Consumers who care about the quality of their food choices often report that they choose free (or organic) meat over industrially produced meat. Because they consider this type of meat to be the best option for their choice or to consume meat produced by intensive animal husbandry, it is considered unacceptable. However, the possible effects of these factors of pressure and tension on consumer choice depend on the transparency of the meat market [29].

To be successful, vegetable meat must have a meaty taste. Taste characteristics (including mouthfeel) are critical for motivating meat consumers to change their dietary habits by reducing meat consumption. Other items may also act as a duty, for instance, food additives [30].

Plant diets are more sustainable than meat diets because they use far fewer natural resources and have lower environmental impact. Global population discharge and increased appetite for animal food destabilize the food system. Food security and stability are in a period of conflict. Redirecting (to avoid a collision) requires drastic downward changes in the consumption of meat and dairy products by many segments of the world. Although, other approaches must be pursued, they are not sufficient to sustain the global food system, and therefore change. The diet is an inevitable strategy [4].

In recent years, some research groups have focused on the study of imperfect substitutes of animal proteins with plant proteins in the diet as an option to lower animal protein intake. This method has been shown to be helpful in following the cooperative, manners of these combined protein structures with creative potential. Some jointed protein structures have been indicated to be highly effective in regulation the texture of protein gels, the ability to form low-cost edible films, and the production of stable emulsions and foams [23].

Plant proteins

Plants are part of the human diet to create necessary substances for a sustainable life. Plant proteins are cheaper and more abundant than animal proteins, but their consumption remains low. Currently, most plant proteins are produced side by side. Animal proteins are used, and 15% of them are converted into animal proteins for human consumption, 85% of which are wasted [13] (Figure 1).

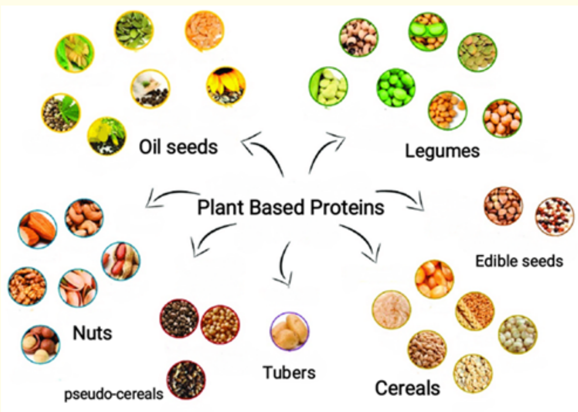

Figure 1: Plant-based protein sources.

The 2015 American Dietetic Guidelines Committee Scientific Report for Americans places strong attention on the need to change the use of plant-based protein foods due to the environmental influence of relying on animal-based protein sources [31].

As awareness of the environmental consequences of food selection increases, so does consumer demand for plant-based options for meat and other animal foods, partly due to the lower impact of plant-based foods on the environment. Recently, owing to health concerns, religious restrictions, and the growing trend of vegetarianism, the food industry has focused on consuming vegetable proteins instead of animal proteins [32].

Classification of plant proteins

The storage of plant proteins was classified according to their solubility and the amount of extraction in various solvents, which are albumins, globulins, prolamins and glutelins. Albumins are soluble in water, while globulins are insoluble; however in solutions, salt can be dissolved. Prolamins are not soluble in aqueous and saline solutions but can be extracted in concentrated solutions of water and alcohol. Glotulins can be extracted from dilute alkaline and acidic solutions [33].

Functional properties of plant proteins

functional properties of proteins are classified into three main groups based on their mechanism of action: 1) hydration properties (water and oil absorption, state, thickening, and wetting) 2) protein properties and rheological properties (viscosity, elasticity Adhesion, aggregation, and gel formation), and 3) properties related to the protein surface (emulsion and foaming, formation of protein-lipid films, flexibility) [34].

Solubility properties

Solubility is an important functional index of proteins because it affects the sensory characteristics of food. This index represents the balance between the function of protein-protein and protein-solvent function. Factors such as temperature change, pH, freezing, ionic bonding, and drying cause changes in the protein structure. This affects the function of the protein [35]. In addition, protein solubility plays a significant role in other functional properties, such as emulsion and foam, and proteins have the lowest solubility at their isoelectric point [19].

Another factor affecting protein solubility is the balance between protein-water and protein-protein interactions. Protein interactions increase solubility and protein-protein interactions cause dissolution and eventual protein deposition [36].

Emulsification properties

The formation of emulsions and their stability are based on the activity of proteins at the liquid-liquid level; therefore so proteins are used as strong emulsifiers in commercial foods [37]. Food is composed of various materials that may or may not be mixed together, which are stable in some cases or created using an emulsifier. An emulsion can be defined as a substance that causes the mixing of two immiscible substances and causes stability. And their uniformity can be defined [38].

Foaming properties

Foams are colloidal systems with a continuous liquid phase and a dispersed gas phase. Foam formation requires proteins that can dissolve in the continuous phase and open quickly. The foaming capacity of a protein depends on its flexibility. molecular acceptability, reduction of surface tension, charge and its distribution, hydrophilic properties and hydrodynamic properties were determined [39].

Gelling properties

The gel-forming capacity of proteins is important for storing water, sugars, flavors, and food in the food industry. The lowest concentration of gel formation indicates good gelation capacity of proteins. In general, higher protein concentrations produce stronger gels. Recent research has stated that the extraction of proteins may cause the loss of albumin, resulting in an increase in the concentration of globulins in the final products, which also causes the formation of gels [19].

Water and oil absorption capacity

WAC or OAC is defined as the amount of water or fat absorbed per gram of protein, because proteins have both hydrophilic and hydrophobic properties that interact with water and oil in foods. If protein isolates can be incorporated into various food products, WAC it is a useful sign for predicting moisture loss and OAC It can reflect the hydrophobic capacity of the protein. Water absorption capacity is the most important physical characteristic of proteins, and may be influenced by protein composition, amino acid composition, and the hydrophobicity ratio. It also has a profound effect on the properties of food in terms of food spoilage and is an important factor in bakery products, such as bread and cake. Confectionery products and viscous foods such as soup [39,40].

Production of protein isolates

The expansion of proteins extracted from plants, grains, algae, etc., requires the disintegration of tissue structures to separate different components. The goal of these processes is not to replace protein compounds in the early stages, which is the goal of the solution are commercially valuable. Extraction is often a challenge, and to improve protein recovery, pretreatments such as electric field technology, cutting, and using microwaves, have been suggested. In addition, little research has been conducted on the effects of nutritional quality and digestibility, and the need for the whole approach is to pay attention to these aspects so that valuable proteins can be replaced [41].

Protein extraction methodologies

Air classification

Air classification is a milling method that allows one to break down into diffuse flours and high protein content. The offspring of the pulse were discretized by having areas with particles of two sizes and densities. The air classifier can separate proteins (coarse and heavy) from this fine-grained phenomenon. During the air classification, whole seeds hard-crushed seeds, and flour belong to the same stream. It is another air) was spiraled to separate it from the protein. This process can be repeated to heal again, because it protects the body again, but it protects the body if the body can provide a significant level of adhesion [39] (Figure 2).

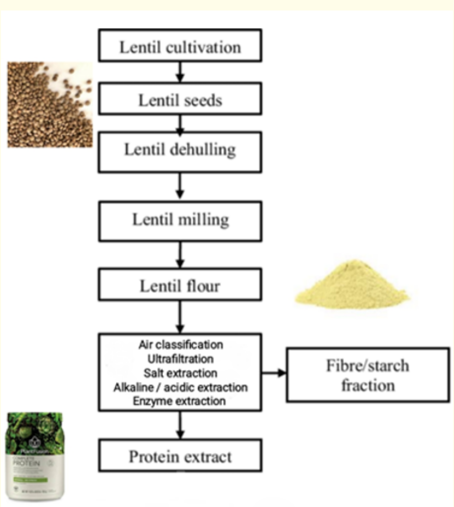

Figure 2: Protein extraction stages from lentil seeds.

Ultrafiltration

Membrane separation is frequently used as an alternative to isoelectric precipitation. In this process, the supernatant obtained from alkaline or acid extraction is subjected to ultrafiltration, or diafiltration to concentrate proteins. Membranes of specific molecular weights must be carefully selected to retain proteins of interest. Ultrafiltration is often used to separate salts from proteins. Membrane deposition is the main factor in the protein ultrafiltration process, which is primarily the absorption and deposition of protein on the surface of the membrane and substrate [39].

Salt extraction

Once extracted from the cells, the proteins are sedimented using a desalination method, with reactants such as ammonium sulfate or a hydrophobic ether such as ethanol. In a number of investigations, it is obvious that most of the proteins in plant cells can be improved using these methods; however, the scientific challenge is to achieve a variety of representations of all the proteins in the plant matrix using techniques such as gel electrophoresis. Under denaturing conditions, the protein chains were destroyed. The third structure of proteins, which gives them functional properties, is often breaks up during extraction and separation, thereby reducing their potential applications in the food industry. In addition, if these proteins are neutral in an untidiness subsidiary structure under pH conditions, bioavailability is available, which has a negative impact on their potential use in livestock feed or active food [42].

Alkaline/acidic extraction

Neutral acidic solutions have been used, (for example as hydrothermal) and alkaline treatments to dissolve residual food proteins. Alkaline extraction is more efficient than acid extraction. For example, the extraction of albumin and globulins may be preferred [43,44]. Alkaline extraction is the most commonly used method. It is commonly used to improve the ability to extract proteins, and is an environmentally friendly method compared to the use of organic solvents. Alkaline use can break disulfide cross-links in proteins, for example in grain-derived proteins. In addition, neutral and acidic amino acids ionize at the basic pH, thus increasing the solubility of the protein [45].

Enzymatic extraction

Protein extraction using a chemical approach can destroy not only the separation of polysaccharides in the plant matrix but also the extracted proteins with simultaneous loss of function and bioavailability. Many enzymes show optimal movement, depending on the type of enzyme, from weakly acidic to weakly alkaline. In general, the optimal activity of most carbohydrates occurs under low-acidic conditions, whereas most proteases occur under weakly alkaline conditions [46]. In addition, other methods that include more active proteins, such as trypsin inhibitory proteins, are used. Moreover, specific saline and alkaline conditions were observed to increase the state of the protein, which reduced the specific activity of the trypsin inhibitor [47].

Lentils

Lentils (Medikus culinaris Lens) are one of the most valuable types of legumes because of their nutritional quality and because they provide high amounts of nutrients necessary for the body. It is rich in carbohydrates, proteins, vitamins, and minerals. In addition, lentils complement grain proteins and improve the nutritional value of the body and prevent obesity, cardiovascular diseases, diabetes and cancer [49].

Chemical combination and nutritional value

The protein content of lentils is approximately 17% to 30%, which includes 45% legumin, 17% albumin, 11% glutelin, 4% vicilin, and 3% prolamin [70]. Like most beans, lentil grains composed of two-thirds of carbohydrates and 24-30 percent proteins. Furthermore, lentil is a good source of special amino acids such as lysine and arginine which are important for equality and lack the crucial amino acids in food regimes full of grains[51]. Both Starch and lentil proteins offer new sources of new materials. New sources of cheap proteins will introduce new choices for dairy industries, where cheaper proteins are needed to replace available proteins [52]. Lentils (Because of their nutritional quality) one of the most important axial pulses in the world; their sources are complex carbohydrates, proteins, fibers, vitamins, minerals, and high energy [53]. Research has shown that lentils may provide more than 12-14 grams of total prebiotic carbohydrates and a range of micronutrients per 100 g of meal. In addition, this level can be used after cooking, cooling and heating increases [54]. Interest in producing and using numbers in food preparation has increased in recent decades owing to its high nutritional value and fast time. Acts are a good source of carbohydrates (e.g., fiber, release resistant to oligosaccharides) proteins, vitamins, and minerals). Due to the high composition of amino acids, such as lysine and arginine, lentils can supplement cereal proteins and improve the overall nutritional value of the body [55].

Health purpose application of lentils

The foods full of fibers have an important effect in maintaining a low BMI. The use of foods full of fiber can help reach fullness faster, and this effect is permanent because of the time digestion takes in the intestine for foods that are full of fiber. Consuming small amounts of glycemic index foods will cause an increase in colcistocenin (peptide digestive system and control of hunger) and fullness. Moreover, a decrease in insulin level and a significant decrease in weight were higher for those who had a low glycemic index regime than for those with glycemic index regime. Most pulses are full of fiber; therefore they serve as low-glycemic index foods, and it is possible to decrease weight and fat reduction [56].

Millions of people around the world suffer from hygiene problems due to inappropriate nutrition. Fatness is a public hygiene concern worldwide for decades, which has been forgotten, and nowadays, fatness has infected many parts of the world. The global population is expected to increase by 90 million per year, and the demand for food is expected to double by 2050. Therefore, to fight fatness in worldwide scale, new methods of nutritious foods, beyond the ways concentrated on food's calories are needed. The study of traditional beans and lentils can lead to a better nutrition solution to increase human health. Recent studies have demonstrated that food regimes full of carbohydrate prebiotics could reduce non-infection sicknesses related to fatness by justification of rectal bacteria. Studies have shown that lentils could provide more than 13-14 grams of prebiotic carbohydrates and micronutrients in each 100g meal. Moreover, this level could double after cooking, cooling, and reheating. Therefore, lentils could offer new opportunities as a solution to fatness and extra weight problems. Therefore, a comprehensive systematic approach is needed to combine agricultural production and human health [54].

Limitations of lentils consumption

However, the importance of prebiotics in lentils and other pulses is not completely understood. As hygiene concerns remain as big problem, the demand for foods that amplify health is growing. Clear disagreements with the content of oligosaccharides of the raffinose family (RFO) in lentils and other pulses may be a sign of transient density of beneficial species in the microflora of the intestine. Therefore, the consumers and businessmen must be considered. Green Lentil has a lower (RFO) concentration and could be better for north American consumers while it is more popular. In all lentil products, cooling after cooking could increase the fiber content of the food regime and prebiotic contents of food. These phenomena could have some consequences for "ready to eat" lentil products which are cooked and cooled. Lentil is a nutritious food product, with high levels of protein and fiber that have supplied people for centuries. However, cooking alters the total density of lentil prebiotics. Red lentils more RFO content than green lentils. Cooling and reheating in complete green and red lentils, possibly because of the hydrolysis by heat or acids, along with loos of RFO. Resistant starch (RS) at higher concentrations are in green lentil products than in red lentil, and it will increase even with cooling. Lentil is advised as a prebiotic food source but more studies are needed for a higher concentration definition of RFO and RS in different parts of the seed and the reduction mechanism of (RFO) [57].

Anti-nutrition factors (ANF)

Legumes contains anti-nutritional components that limit their usage. These components include trypsin inhibitors, phytic acid, tannins, and oligosaccharides. Trypsin inhibitors are proteins with low molecular weights that are able to bind and deactivate trypsin enzymes [78]. Phytic acid reduces the bioavailability of minerals and oligosaccharides cause bloats. One of the main disadvantages of tannin in lentils is the color change of the seed. In addition to the color change of seeds, tannins are connected to proteins by hydrogen connections and other hydrophobic actions and reactions, and thereby reducing food quality [58].

Non-protein anti-nutrition factors in pulses include alkaloids, phytic acid, and some other combinations of special phenolics such as tannin and saponine [59]. Alkaloids, which play a role in plant defense systems, are naturally existing amines that can produce a non-delicious taste. Poisonous effects can cause disorders of the nervous system, digestion, reproduction and immunity [60]. Thermal processes that increase cooking will reduce tannins, and fhytic acid pulses significantly, and the process and diversity affect the composition of minerals and anti-nutrition. The majority of studies illustrate significant differences in the approximate composition, food fiber, minerals, oligosaccharides, trypsin avoidance action, fhytic acid, and tannin of different types of lentils. Cooking increases raw protein, starch, non-dissolved food fiber, complete food fiber, resistant starch, calcium, copper and manganese while reducing ash, dissolved food fiber, iron and potassium [61].

The effects of microwave cooking and other traditional methods, such as boiling and autoclaving, on food composition and anti-nutrition factors have been studied. Cooking treatments reduce lysine density and tryptophan amino acids, which are present in sulfur and perfumes. The existing waste of minerals in cooked lentil with a microwave set is not that much to be cooked with an autoclave or boiling. All cooking treatments increase the digestion and lentils protein performance ratio. Based on these results, cooking with microwaves not only improves the nutritional quality of lentils, but also it reduces cooking time and maintain the most food value inside [62].

Lentil processing

Lentil processing is divided into three levels: primary, secondary and tertiary processing. Primary processing includes different steps, such as washing, sorting, and packaging to deliver lentils to customers or later processing. The basis of primary processing is to use mechanical methods of sorting to separate lentil grains into the cleanest and the best quality, which is defined by size, shape, color, and density [48]. Secondary processing includes the decomposition, division and arrangement of complete or ground seeds. third level of processing includes powder and crushing complete and or grinded seeds and separating the protein and full of starch parts for use in food products [48].

Lentil protein isolation methodology

Plant proteins can be separated using wet or dry processes. In the dry method, parts of the plant (for example, roots, stems, or seeds) are crushed into fine powders that separate starch and protein based on their density. Although this process is relatively easy than the wet method, the separation efficiency is not high enough to produce a sufficient protein concentration, on the other hand, the wet method involves dissolving the protein in an alkaline solution, separating the soluble protein from the unsolvable matter, and precipitating the soluble protein to recover it from the solution using a number of physical methods. Precipitation usually occurs at the isoelectric point (pi), which is the protein with the lowest conductivity. The pH of the lentil protein is about4.5. The authors used alkaline conditions to extract the protein, followed by separation of the unsolvable parts and precipitation of soluble protein with acid, ammonium sulfate, methanol, and ethanol. The percentage of protein regained in isolates by all methods was in the area of 80-100% [48].

Production of lentil protein isolate powder (LPI)

Isolated lentil protein powders were produced using spray drying, freeze-drying and spot-drying methods. They all concluded that the chemical composition and maximum thermal denaturation temperature of the powders acquired using these three drying methods were not considerably different. However, spray-dried and frozen powders of LPI had considerably higher solubility (81.19% and 78.39%, respectively) than the mole-dried powders (50. 34%).The LPI gels prepared by heat treatment exhibited normal viscoelastic behaviores confirmed by a stress relief test. Spray-dried LPI powder had the best state and gel properties, which were improved by rheological tests (high elastic modulus and tangential values). A low loss (texture) of high gel resistance was confirmed. The spray-dried LPI powders showed a weak water absorption capacity compared to the freeze-dried LPI powders. Freeze-dried LPI powder exhibited good gel conditions and capability, similar to spray-dried LPI. The dried LPI powder in the mole had the lowest state and the highest level of denaturation (the lowest number of protein bonds), which compared to the spray-dried and freeze-dried LPI powders, had a weak gel-forming ability. LPI preparation can considerably affects physicochemical properties, which in turn negatively affects protein function [63].

Physicochemical and functional properties of lentil proteins

The use of proteins is related to their functional properties such as water and oil absorption, foam formation and stability, emulsion formation and stability, gel formation and solubility. These functional properties can have a significant impact on the formulation of foods and additives. Understanding the physical and chemical properties of proteins and their relationship with functional properties can help in food programs [48].

Solubility properties

Solubility is one of the most prominent functional properties of proteins because other functional properties depend on it. In addition, pH is an important indicator of protein status that to determines the behavior of isolated proteins in the food process [47]. The thermodynamic index is the balance between protein-protein and protein-halide interactions, and changes in factors such as temperature, pH, ion resistance, freezing, heating, and drying lead to changes in protein structures, which in turn affect proteins [64]. Lentil protein showed a U-shaped bend.

Water and Oil absorption

Water and oil absorption capacities are important indicators for evaluating proteins in the food industry. Water absorption capacity and water retention in different foods are related to the amino acids composition, spatial arrangement of proteins, degree of hydrophobicity and hydrophilicity of proteins, and presence of hydrophilic carbohydrates [65]. The oil absorption capacity is defined as the physical confinement of oil and it is attributed to the non-polar chains and spatial shape of the protein [40].

Emulsification properties

The extracted lentil protein was used as an emulsifier in oil and water, which showed that properties such as surface hydrophobicity, surface tension, and surface charge affect emulsion properties. In addition, the presence of NaCl improved emulsion capacity, but the stability of the emulsion was due to the presence of ions. In addition, this heat initially improved the emulsion stability and then had a negative effect owing to increased accumulation. Molecular flexibility can also be increased by reducing disulfide bonds [66].

Gelling properties

Food proteins, especially those found in legumes, are spherical and can form gels through aggregation with other proteins. The heating of legume globulins may lead to the formation of gels with different properties. In general, stronger gels are produced at the higher concentrations. In addition, to obtain a protein isolate, it is possible to destroy albumins soluble in water, and as a result, the concentration of globulins in the products increases [67].

Foaming properties

Foaming capacity is based on the ability of proteins to reduce surface tension, molecular flexibility, and physicochemical properties (hydrophilic, load and distribution, and hydrodynamic properties). An increase in the sample concentration intensifies the protein-protein reactions, which increase the viscosity and facilitate the formation of a multilayer protein film attached to its surface. Also, an increase in sample concentration can lead to thicker films [68].

Interactions of lentil protein

Proteins are basic macromolecules in the human diet which are necessary for the growth and repair of cells in the body. Proteins have the ability to form a gel by heating in water at a certain temperature and concentration, which creates a specific structure and texture in many food products. The ability of proteins from a stable structure is important for most foods. It should be noted that the extraction conditions are important. A high pH and temperature lead to a decrease in the quality of minerals, nutrients, and proteins. In addition, molecules are put together by weak bonds such as hydrogen and van der Waals bonds, but the bonds of protein gels are covalent and very strong [52].

Conclusion

Due to the increasing population and human need for food resources, nutrients and insufficient resources in the future will be in trouble. The body needs, especially proteins, to replace plant protein sources with animal ones, which have become more popular in recent years. Many people have become interested in using these sources due to environmental issues, and the protection of animal rights, including legumes, are the main and most important source of plant protein supply, which is one of the most complete and essential sources of lentils, including carbohydrates, proteins, and dietary fiber, which according to the desired methods can meet the human needs of the world

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