Agricultural Research & Technology
Open Access Journal
ISSN: 2471-6774

Juniper Publishers
key to the Researchers

Mini Review
Volume 13 Issue 2 - January 2018
DOI: 10.19080/ARTOAJ.2018.13.555876

Agri Res & Tech: Open Access J

Utilization of Agri By-Products for Value Addition as a Protein Source

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Submission: October 10, 2017; **Published:** January 09, 2018

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Abstract

Agriculture is essential for the well-being of the society consuming 70 percent of the global water resources and occupies about 40 percent of the total land surface. With increasing world population there is a growing demand for food production worldwide, arising the need for relatively low-cost foods, which have reduced influence on the environment. Proteins form the essential and integral part of our food. Many plant-based by-products have captured the attention of researchers and industries. Here, the review gives some insight into the various sources available, which can be exploited for extraction of proteins for human consumption. It will cover some of the studies related to utilization of oil seed by-products, by-products generated from rice milling and legume industry that are rich sources of proteins.

Keywords: Oil seed cakes; Legume milling by-products; Tomato seeds; Watermelon seeds

Introduction

The growing awareness for nutrition, health, quality and environmental consciousness of consumers are compelling the food industries to search for sources having good quality and sustainable protein sources. Plant proteins, primarily originating from oilseeds and industrial by-products have gained attention in recent research. It may be due to relatively low cost and reduced influence on the environment, plant proteins have captured a lot of attention to the researcher and industry.

The health and nutritional profile of a nation determines the quality of life regarding productivity and economic development of a nation. Proteins form the fundamental and integral part of the food components, both nutritionally and functionally. Until date, foods were required to be 'nutritive', which now is expected to be 'nutraceutical' providing preventive disease components in addition to nutrition. Essential amino acids in the protein determine the nutritional value of the raw material. There are many plant-based by-products such as oil seed cakes from soy, sesame, sunflower, groundnut and some by-products from rice milling and legume industry, which are rich sources of proteins. These by-products were used as animal feed but work is being carried out to improve the quality of protein for human consumption.

Oil seed cake as a source of protein

Traditionally oilseeds are valued only for oil content, which ranges between 15-40%. The commercial importance of proteins in oilseed meals was recognized in early 60's. Oil industries, in addition to supplying oil, started providing protein rich meal for animal feed. Work towards harnessing vegetable proteins from oilseeds like groundnut, rape/mustard, sunflower, sesame, soybean, niger, and others was initiated for human consumption. A lot of basic work is reported in the literature on the removal of anti-nutritional factors, which are present in the cake. Extraction of proteins from various oilseed meals has been standardized for maximum extractability. Removal of the insoluble carbohydrates and other impurities enrich the meal to obtain protein concentrates.

Oilseeds and legumes account for the largest proportion of annual global seed protein production, mainly due to high protein content. The five top oilseed crops considered based on annual production are soybean, cotton seed, peanut, rape seed/canola, and sunflower seed. Soybean, the most cultivated plant in the world is an important protein source formed by a complex mixture of different proteins. In oilseeds particularly, soy proteins have attracted most interest in recent years due

to scientific research pointing towards health benefits derived from soy protein consumption. A soy protein concentrate free of beany flavor is prepared to have a protein content above 66% with minimal trypsin inhibitor activity and reduced flatulence causing oligosaccharides [1].

Palm oil kernel protein

Oil palm (Elaeis guineensis) is one of the highest oil-yielding crops in the world. Palm kernel meal (PKM), a by-product obtained after oil extraction of oil palm kernels is used widely as a source of protein in animal diets. The seed storage globulins from various sources make a significant contribution to the human diet. Studies on palm kernel globulin isolate is reported to have anti-cancer activity after ex-vivo digestion, therefore could be used as a health-beneficial dietary protein [2].

Flaxseed protein globulin isolate

To obtain efficient extractability of salt soluble protein (globulin) from flax seeds, the seeds were separated from the hulls by giving sufficient moisture to the seeds, which was followed by abrasive scrubbing and dehulling to remove the mucilage and the hulls. The dehulled and defatted flax seed meal was the starting material for the preparation of salt soluble protein having a protein content of 93%. The in-vitro digestibility shows the protein to be completely digestible [3].

Proteins from milling by-products

Rice bran, a rice-milling by-product is associated with nutritional benefits due to the presence of high dietary fiber content, presence of antioxidants, vitamins, and minerals. However, the presence of lipase and lipoxygenase initiates rancidity on milling and limits its usage. Rice bran contains 15% protein 22% fat and 54% carbohydrates [4]. Protein extracted from rice bran have shown high content of arginine. Post-oral administration of various dosages of arginine fractions from rice bran protein hydrolysate remarkably regulated hypertension in DOCA-salt induced hypertensive rats through increased cGMP levels and NOS activity in the plasma and kidney tissue extracts. ACE levels were significantly affected in both kidney and plasma samples [5]. Extraction of γ-oryzanol from soap stock has been carried out using various solvents [6]. A novel metallo protease has been isolated and purified from rice bran, and OsI_13867 has been identified as Cupincin. The cleavage specificity of Cupincin suggested its definite function in rice [7].

Protein isolate from pigeon pea by-product

During pigeon pea seed processing, the by-products obtained include seed powder, broken seed, and seed coat. This underutilized by-product with 20% protein is a rich source of protein. The protein extractability at different pH conditions exhibited maximum extractability at both acidic and alkaline conditions. The protein concentrate (PC) under acidic conditions showed 85% protein content. Pepsin hydrolysis of PC resulted in the formation of gel on heating. The gelling ability of pigeon pea PC could be exploited as a protein based carrier system suggesting use of pepsin hydrolysate as a functional food material [8].

Protein from tomato processing by-product

Tomato (Lycopersicon esculentum L.) is grown throughout the world for its fruit with annual production of nearly 100 million tons [9]. The majorities of tomatoes are processed into food products such as juices, ketchup, sauces, paste, puree and powder, and simultaneously generate large quantities of solid by-products, mainly peel and seeds, usually raising environmental concerns. Tomato seed protein isolate (92%) prepared from tomato seed meal had a calculated PER of 2.66. The protein isolates contained all essential amino acids (including lysine), meeting the minimum requirements of reference protein for preschool children aged 1-2 years (WHO/FAO/UNU). The tomato seed protein isolate showed negligible levels of phytate (3.48g/g) and trypsin inhibitory activity (2.655TIU/mg). This study has recognized the importance of underutilized tomato seeds as a promising source of sustainable protein adjunct for future food formulations [10].

Protein from watermelon by-products

Watermelon (Citrullus vulgaris) seeds are underutilized fruit byproducts. India is the second largest producer of watermelon fruit among the Asian countries producing 255,000 MT per year, generating 2550 MT of seeds per year (FAOSTAT, 2009). Protein and fat together account for 3/4th the weight of the seeds and is grouped under oilseed group, but it has received less attention as an oilseed. The chemical composition of protein isolate with 88% protein from watermelon seed meal suggests its suitability as a matrix for mineral fortification. Its functional properties suggest its suitability for food formulations [11].

Pea a source of protein

Proteins from legumes, such as pea (Pisum sativum L.) are an excellent source of lysine, antifungal bioactive peptides or dietary lectins with health-promoting properties. The in-vitro pea protein digestibility studies demonstrated that high-pressure processing (HPP) treatment enhanced the degree and rate of proteolysis as compared to autoclave treatment [12].

Conclusion

There are many reports on the extraction of proteins from by-products now the challenge lies in the large-scale production of these proteins for safe human consumption

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How to cite this article: Purnima K T. Utilization of Agri By-Products for Value Addition as a Protein Source. Agri Res & Tech: Open Access J. 2018; 13(2): 555876. DOI: 10.19080/ARTOAJ.2018.13.555876

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