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Approach for Enriched Nutrition through Pulse Consumption

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ABSTRACT

Pulses are the richest source of plant proteins. They are also high in dietary fibres and complex carbohydrates leading to low GI (*Glycemic index*) than cereals and fibres that result in slow release of glucose in blood stream proving beneficial to diabetic people. Pulse help to lower cholesterol as their fibres constitute more amylose than amylopectin. They are natural sources of minerals which offer unique opportunity to combat against specific malnutrition known as hidden hunger. Being natural reservoir of antioxidants pulses tend to provide protective shield against oxidative stress which is closely linked to cancer and cardiovascular diseases. It is now being demonstrated that so called anti nutrients of pulse seeds are involved in health promoting processes and beneficial cellular effects which are gaining increasing attention for human health. Efforts should focus on developing attractive, convenient ready to eat and tasty pulse based food products contributing to the diversification of healthier and more nutritional diets.

Keywords: Pulses, health, plant proteins, dietary fibre

The mature seeds of plants of the family Fabaceae commonly known as "grain legumes" or pulses are major food staffs in most countries and indispensable protein source for third world populations. The major pulses includedry peas, lentils, chickpeas, green gram (*mung*), black gram (*mash kalai*), red gram (*arhar*) etc. Around 60% of total pulse production is from Asia. India is one of the largest producers of pulses. Daily per capita consumption of pulses and their products in Asia is about 110g while in US it only 9g with the result that Asian population show lower risk of coronary heart diseases (Kahlon *et al.*, 2005).

Pulses, rich in protein, are considered as good source of nutrients and are also popularly recognised as poor man's meat. Their consumption assumes great significance and importance in the third world countries where protein energy malnutrition is a major nutritional problem. Pulses are also good sources of minerals (Fe, Zn etc.) and vitamins. They contain variety of phytochemicals and flavonoides (anthocyanins, flavones, isoflavones, phenolic acid etc.) with distinct antioxidant property. The utilization of pulses have great association with many physiological and health benefits, such as prevention of cardiovascular disease, obesity, diabetes mellitus and cancer (Arnoldi *et al.*, 2015).

Sadly there is a downward trend in pulse consumption even in countries like India and Spain known as traditional pulse consuming countries. This scenario is however, gradually changing due to the growing awareness of the environmental impact of food choices that has generated an increase in the consumption of plant vs. Animal foods and people are looking for a healthier and more sustainable life style to satisfy the demand of today's consumer. There is urgent need to develop convenient tasty pulse products. It is also increasingly important to have greater and clear understanding of nutritional quality of pulse seeds in terms of protein, starch, fibre, minerals including the ant nutritional compounds demonstrating health benefits linked to pulse consumption.

Pulse Protein and Quality

Proteins are essential in food which provides essential and non-essential amino acids and nitrogen for human health. Pulses are generally rich in protein ranging from 23% in chickpea to 29% in lentil and carbohydrate is around 64 to 69% but low in fat raging from 0.8% in lentil to 5% in chickpea. The major proteins are globulin (legmin – 115 andviciline – 75) and albumin. Importantly proteins from cereals and those are pulse complement each other in diet. The pulse proteins are deficient in methionine and cysteine (sulphur containing amino acid) while rich in lysine. In contrast cereal proteins are short of lysine but high n methionine and cysteine. Proteins digestibility is an important parameter to access nutritional value. For this purpose the digestible indispensable Amino acid score (DIAAS) has been recommended by the expert panel (FAO, 2013). Though pulse protein digestibility is considered to be relatively poor there is still limited information on DIAAS for pulses.

Protein and peptides in pulse record health benefits. Peptides with angiotensin-1 converting enzyme (ACE) inhibitory properties are recovered from the protein hydrolysates of lentil, pea, bean and chickpea. ACE plays a role in constriction that results in the elevation of blood pressure (hypertension). The lower IC50 (the half maximal inhibitory concentration) would indicate higher ACE inhibitory activity. The value of IC50 for lentil protein hydrolysate ranges from 53 to 111mg/ml which is lower than other pulses suggesting the importance of lentil influencing blood pressure. It has also been demonstrated that pulse flours, protein concentrates and also lates have the capacity to bird bile acids (Barbanna and Boye, 2011). Removal of bile acids (synthesized from cholesterol in the liver) through binding of foods in the gastro intestinal tract, followed by their elimination, increases cholesterol metabolism which may help tp reduce cholesterol levels in blood (Kohlon and Woodruff, 2002). Pulse proteins are also of interest for the functionality they confer to foods. The major important functional property of proteins includes solubility, water binding capacity, fat binding capacity, emulsification etc. These functional properties help use these proteins either or as component in flours and other pulse products (Boye and Ma, 2012).

Dietary Fibres

Pulses are good source of structural carbohydrates due to their higher soluble dietaryfibre (SDF) content compared to cereals and tubers. The dietaryfibre (DF) fractions are of nutritional interest because of their important physiological properties that can promote health. The total dictory fibre (TDF) and SDF levels vary depending upon the pulse species. In general pulse exhibit levels of TDF from 9to32g/100g dry matter, which is higher than other starchy foods such as cereals (Tharanathan and Mahadevamma, 2003). The contains of insoluble dietaryfibre (IDF) are higher than SDF with IDF being the main fraction as 75-96% of TDF for the studied pulses (Mahadevamma and Tharanathan, 2004), There are different IDF / SDF reties among the pulse species with peas exhibiting the largest SDF fraction (≤ 25% of TDF). The ratio of insoluble and soluble fibre plays important role in influencing potential health benefits with the optimum ratio being 3:1 (Aguilera *et al.*, 2009C). Significantly, germination promotes DF fractions and improves IDF/SDF ratio due to the metabolic reaction accompanied by an increase of polysaccharides, 2007). It is to be noted that pulse with the high level of pectic polysaccharides in IDF fraction in associated with the potential physiological effects in the human upper gastrointestinal tract (Tiwari and Cummins, 2011). A strong positive correlation between the content of uronic acid of IDF and cation exchange capacity has been observed in pulse fibres which would facilitate the capacity to bind heavy metal ions which can act as cation exchangers (Elleuch *et al.*, 2011).

Physiological Properties and Digestibility of Pulse Starches

Starch is the most abundant carbohydrate in pulse, accounting for 22-45% of the seed. Pulse starches consist of amylose and amylopectin and usually amylose is greater than 30%. The pulse starch exhibits lower glycemic index (GI) than cereals and tubers because of high level of amylose and strong interactions between amylose chains. Pigeon pea starch records lowest in vitro GI values of around 44, which it is about for *mung bean* and *chickpea*. The low GI means slow release of glucose into blood stream which is beneficial for people with diabetes (Rizkalla *et al.*, 2002).

Pulse starches are les digestible than cereal starches because they contain less amount of rapidly digestible starch (RDS). The RDS fraction causes sudden increase in blood glucose level after ingestion, but slow digestible starch (SDS) leads slow release of glucose in blood stream and it is digested completely in the small intestine at a lower rate than RDS. The resistant starch fraction (RS) cannot be hydrolysed in the small intestine and after reaching the large intestine is fermented by the gut micro flora. According to the SDS content of pulse starches the common pulses follow the following order: mung bean> chickpea>pea>lentil>black gram>pigeon pea. High amounts of SDS and RS could be linked with potential physiological benefits, such as a reduction of potential risk factors for the metabolic syndrome, diabetes management, protection against colon cancer and mental performance (Lehmann and Robin, 2007). The dietary intervention of a substantially increased intake of pulses is advised to replace readily digested foods. Pulse starches have high tendency towards retrogression(Formation of crystalline aggregates from gelatinised starch and gelled texture). This makes them suitable for use in many food products as gelling agents. Such greater extent of retrogression than cereal and tuber starches may be due to their higher amylase content (Hoover *et al.,* 2010)

Natural Source of Antioxidants

Pulse seeds are valuable source of natural antioxidants such as phenolic compounds, tocopherols etc. The antioxidants can protect against oxidative stress which is closely linked to cancer and cardiovascular disease. The potential antioxidant capacity of pulse seeds depends on total phenolic content. Lentils possess the highest content of total phenolics. The major phenolic compounds are phenolic acids, flavoroids and pyrocyanadins. The low levels of phenolic acids are reported in mung bean, lentil, faba bean and pigeon pea, while cowpea records very high amount. The majority of flavonoides are present in the seeds as glycosides. In the seeds of pulses r tocopherol predominates and its level is greatest in pigeon pea, pea and lentil (Ryan *et al.,* 2007). The germination plays an important role in antioxidant properties of pulse seeds. The antioxidant activity estimated by β-carotene assay in mung bean sprouts has been found to be the highest in the first day of germination. The germinated mung bean seeds express significant increase in total phenolic. On the contrary, germinated lentil seeds record lower anti-radical capacity than that of the raw seeds. It is to be emphasized that very strong antioxidant activity is displayed by the tannin fraction separated from the pulse crude extract (Amaravicz *et al.,* 2010).

Natural Source of Minerals

About half of the world population suffers from malnutrition of iron, zinc, calcium iodine and selenium (Zhao and Mc Grath, 2009). This is known as "hidden hunger" and iron deficiency becomes the most serious nutritional problem. The pulses are natural rich source of several minerals and are excellent candidate foods for combating malnutrition. Beans are rich in iron, zinc and other micronutrients. Peas low in phytic acid are good source of iron, zinc and magnesium. Mung bean, another pulse with lower phytic acid than pigeon pea is an iron rich food source with wide genetic variability for iron and zinc. Chickpea on the other hand, having low phytic acid is a rich source of selenium and other micronutrients as well in carotenoids which can increase mineral absorption in the human digestive system (Tavarajah and Thavarajah, 2012). These pulse species with enriched mineral concentrations positions themselves as food based solution for global mineral micronutrient malnutrition. Several pulse nutrients interact with each other modulating their respective absorption rates. Efforts are made to increase the concentrations of "promoter substances" to stimulate the absorption of essential minerals and to reduce the concentrations anti-nutrients by interfering with their absorption. The best described "promoter substance" are insulin, amino acids, cysteine, vitamin-D, vitamin-E, provitamin-A, niacin and choline. They promote the absorption of selenium, calcium, phosphorous, iron and zinc, methionine and tryptophan (Brinch – Pedersen *et al.,* 2007).

Riddle of Anti Nutritional Factors: Positive and Negative Role

Many componentsof pulse seeds are recognised as anti-nutrients ranging from metabolites such as vicine and convicine in faba bean or sucrose derived oligosaccharides and tannins. There are also various classes of proteins such as trypsin/chymotrypsin which inhibit the action of proteases. Vicin and

Convicin in fababean are thermostable pyrimidine glucoside compounds which are associated with favism i.e. haemolytic anaemia. The non-protein amino acid β-ODAP found in grass pea that if consumed in large quantities for extended periods can lead to neurolathyrism, a neurotoxin disease (Rao *et al.,* 1964). However, activation of protein kinase C by β-ODAP adds a new positive dimension for investigating its therapeutic potential in such areas as Alzheimer's disease, hypoxice and the long term potentiation of neurons essential for memory (Rao, 2011). The plant metabolites α-galactosyl derivatives of sucrose abundant in pulse seeds restrict digestibility in human and other monogastric animals as they lack digestive α-galactosylase consequently dietary oligosaccharides are fermented by bacteria in the large intestine which produce carbon dioxide, methane and hydrogen causing flatulence. This may be perceived to be either an anti-nutritional or a prebiotic effect, for latter benefit, purified oligosaccharides are in demand as food additives for the promotion and maintenance of gut microbial health. This family of compounds is also emerging as important immune stimulators in animals and humans (Van den Ende, 2013). In spite of the negative impact the anti nutrients mug play important beneficial roles in both plant metabolism my play important beneficial roles in both plant metabolism and human health.

It is also widely known that pulse seed metabolites such as saponins are associated with a range of dietary effect from bitterness to bloat. In fact , modified DDMP saponin in pea has been implicated in bitterness (Heng *et al*., 2004) interestingly DDMP and other group B- saponins may also possess in vitro anti cancer properties by modulating cell cycle and inducing apoptosis (Zhang and Popvich, 2009). Currently the involvement of some so called anti-nutrients in health promoting process and beneficial cellular effects is an area that is gaining increasing attention for human health.

Epilogue

The growing awareness of the environment impact of food choices has generated a welcome stimulus in the consumption of plant as animal foods. More and more people are selecting a flexitarian diet (i.e., a plant based diet with the occasional inclusion of meat and fish products), because they are looking for a healthier and more sustainable life style. The nutritional benefits of pulses are well recognized globally. In order to increase consumption of pulses, there is a call for more convenient tasty pulse products that meets the demand of today's consumers. In both the developed and developing worlds pulse fortified cereals products would offer great potential for the creation of many novel nutritional foods (Farooq and Boye, 2011).

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