

Review

The role of oilseeds nutrition in human health: A critical review

Muhammad Farhan Sarwar¹, Muhammad Haroon Sarwar², Muhammad Sarwar^{3*},
Niaz Ahmad Qadri⁴ and Safia Moghal⁴

¹Government College Samanabad, Faisalabad, Punjab, Pakistan.

²Faculty of Medicine and Allied Medical Sciences, Isra University, Hyderabad, Sindh, Pakistan.

³Pakistan Atomic Energy Commission, Nuclear Institute of Agriculture, Tandojam-70060, Sindh, Pakistan.

⁴Hameeda Medicare, Ghulam Muhammadabad, Faisalabad, Punjab, Pakistan.

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This article focuses and reviews on the main types of oilseeds, their role in human health and diseases, and highlights of new developments that may provide even more benefits in the future. Oilseed crops are grown primarily for the oil contained in their seeds. They have been cultivated throughout much of the world for at least four thousand years ago, at that time their primary use was as a lamp oil, but, later on the oils have been used in soaps and for other purposes. Oilseeds are rich in protein, and in addition they contain a high level of fat. Hence, they are not only good sources of protein, but, also concentrated source of energy. The proteins in oilseeds can be fed either as part of the oil-intact seed, or as a meal from which the oil has been removed. Oilseeds and their derivatives vegetable oil and meal are in demand globally, and there is a need to identify and quantify the key issues for their production for different stakeholders to develop and support actions that will ensure a viable future of such crops.

Key words: Oilseeds, bio-diesel, human, health, Pakistan.

INTRODUCTION

Oilseeds are leading suppliers of superior quality and specialty vegetable oils to nutritional products, natural food and premium snack food worldwide. Oil producing crops are corn, oat, cotton, soybean, mustard, camelina, crambe, safflower, sunflower, peanut, rapeseed, coconut, oil palm and olives. Oilseeds produced in most of the countries are mostly used for oil extraction. The oil content of small grains for example, wheat is only 1 to 2%, but that of oilseeds ranges from about 20% for soybean to over 40% for sunflower and rapeseeds like canola. The major world sources of edible seed oils are soybean, sunflower, rapeseed, cotton and peanut. Seed oils from flax (linseed) and castor bean are used for industrial purposes. They do not contain an appreciable

amount of carbohydrate, but, contain high level of B-vitamins. Groundnuts are particularly rich in thiamine and nicotinic acid. Oilseeds add important nutritional value to the diet due to high quality protein and or vegetable oil, together with oil soluble vitamins like vitamin A. Oilseeds, are the largest source of vegetable oils even though most oil-bearing tree fruits provide the highest oil yields (olive, coconut and palm trees) (Gunstone, 2002; Sarwar, 2013). Oilseeds are also used in animal feed because of their high protein content. Their seeds contain energy for the sprouting embryo mainly as oil, compared with cereals, which contain the energy in the form of starch (McKevith, 2005).

There are two quality types of oil:

*Corresponding author. E-mail: drmsarwar64@yahoo.com

(1) Edible oils, used as a food grade oil, that is most often encountered as an odorless frying oil low in unsaturated fats, but, it is also an ingredient in many food products, especially where a healthy oil is required. (2) Industrial oils (although some edible types are also used industrially) - which are not edible, but, have been bred to contain high levels of compounds critical for some industrial processes.

OILSEED CRUSHERS

The post-harvest practices for most of the seeds consist of threshing, shelling or podding and drying, after which the product can be stored like grains. Critical in drying and storage process is the prevention of contamination with fungi and aflatoxin. Crushers are used to extract oil from oilseed. This involves a series of steps which can include mild heat treatment to precondition the seed prior to processing. Next the seed is crushed and flaked and then heated slightly to enhance oil extraction. The flakes are then pre-pressed in a screw press or expeller to reduce the oil content in the seed. For canola, this step reduces the oil content from about 42 to 20%. The press cake is then subjected to one of two types of oil extraction to remove much of the remaining oil. Oil may be extracted using either hexane (solvent) extraction or by cold pressing (expeller). The oil which is produced during extraction process is referred to as crude oil.

OILSEED PRODUCTS

Some of oilseeds such as soybean, cotton, sunflower, canola and flax produce valuable products for use in ruminant, swine, poultry, aquaculture and companion animal diets. Soybean meal is widely available which is actively traded, highly palatable and rich in amino acids. Soy hulls are highly palatable, rich source of fiber, minerals, energy, protein and low-lignin content. Canola meal is a source of vitamins and minerals, high in sulfur, containing amino acids and quality protein source. Cottonseed meal complements variety of plant and animal proteins, and contains 40 percent bypass protein. Cotton seed hulls contains highly digestible cotton linters, very palatable, effective fiber source and complement high concentrate ingredients. Sunflower meal is palatable source of fiber and protein, high roughage factor and complements soybean meal for nutrition requirements. Linseed meal is known for producing sheen in cattle coats, which positively affects rumen fermentation. It is probably blamed that oilseed rape is most definitely a cause of ill health (allergy, hay-fever, conjunctivitis and asthma type symptoms) and should therefore be taken precautions to protect public health, but, there is no scientific evidence confirming that oilseed rape is responsible for allergy or respiratory type symptoms in

peoples. As rape pollen is large and sticky, it does not blow far in any quantity. However, less obvious pollen producing hedgerow plants and trees that flower at the same time may be the real culprits. While all of these factors are important, the development of higher value seed meal markets may be the most significant.

HEALTH BENEFITS OF OILSEEDS

In the most of countries, the focus is on brassica crops, which includes canola, rape and mustard. The word rape as applied to oilseed crops is derived from the Latin word rapum that means turnip. Today turnip rapes and the similar, but, more common swede rapes are grown for their oil and widely recognized by their bright yellow flowers. The bright dandelion-yellow flowers of oilseed rape have been a familiar sight across farmland in spring season. Rapeseed oil is one of the highest yield oils, it has very black seeds, which are like poppy seeds, and they are 45% oil and the other 55% is high protein animal feed. The brassica oilseeds contain a high oil content which makes them a good candidate for producing feedstock oils for bio-diesel. For example, spring canola contains upwards of 42% oil as compared to an oil content of about 20% for soybean (Sarwar et al., 2003, 2004a).

Edible fats and oils are similar in molecular structure; however, fats are solid at room temperature, while, oils are liquid. Fats and oils are essential nutrients, comprising about 40% of the calories in the diet of the average person. Edible vegetable oils are used as salad or cooking oils, or may be solidified (by a process called hydrogenation) to make margarine and shortening. These products supplement or replace animal products (butter, lard), supplies of which are inadequate to meet the needs of an increasing world population. While there are many uses for industrial vegetable oils, but, total world production is only about 3% of that of edible oils. Industrial applications are based on the properties of particular fatty-acid components of these oils. For example, flaxseed oil, rich in the unsaturated fatty acid linolenic, is a drying oil and is used in protective coatings (paints, varnishes). Vegetable oils are used in putty, printing inks, erasers, coating or core oils, greases, plastics, etc. The residue remaining after the oil has been extracted from oilseeds, is an important source of nutrients for farm animals. Oilseed meals from soybean, peanut, rapeseed and flaxseed are rich in protein; when mixed with other ingredients (cereal grains), and they provide nutritionally balanced feeds (Sarwar et al., 2004b; 2011a).

The essential fatty acids contained in hemp seed oil are required in our diet more than any other vitamin, yet our bodies do not naturally produce them. They must be obtained from external sources in the food we eat. These are involved with producing life's energy throughout the

human body and without them, life is not possible. Extensive studies have demonstrated that many common illnesses are related to deficiencies or imbalances of specific fatty acids in the body. Symptoms are often related to a lack of Omega 3 and Omega 6 fatty acids and their derivatives, the prostaglandins. Most people eating a healthful diet, one that includes a balanced ratio of essential fatty acids, also have healthy skin and a strong immune system. Yet some individuals may experience shortages in specific fatty acids or their metabolites due to dysfunctional enzyme systems or other inhibitions in their metabolic pathways caused by genetic, immune-system-related, or even environmental factors. Hemp seed oil also provides an adequate supply of antioxidants (Vitamin E), carotene (precursor to Vitamin A), phytosterols, phospholipids and a number of minerals including calcium, magnesium, sulfur, potassium, phosphorus, along with modest amounts of iron and zinc. Oilseed rape is a very useful crop as the seed is typically 42% oil and the meal left after removing the oil is about 42% crude protein. Proteins serve a variety of functions in the human body such as acting as enzymes, antibodies, and the structural components of tissues, hormones and blood protein. The main function of dietary protein is to supply amino acids for the growth and maintenance of body tissue. Digestion disassembles proteins into their basic building blocks - amino acids. Furthermore, the oil is particularly of high quality and high in monounsaturates, and should logically be a premium product. Today's certain varieties of oilseed rape have been bred to provide oil that is suitable for use in cooking and food processing. Known as vegetable oil, the oil is widely used by the food industry and is now being increasingly processed for use as bio-diesel (Sarwar, 2005, 2008, 2009).

Mustard seeds have been highly prized medicinal as well as culinary spice being in use since ancient times. The seeds are obtained from mustard plant (*Brassica juncea*) which also includes cabbage, broccoli, brussels sprouts etc. Generally perceived as health benefiting spice, mustard seeds are indeed very rich in phytonutrients, minerals, vitamins and anti-oxidants. Mustard greens are an excellent source of essential B-complex vitamins such as folates, niacin, thiamin, riboflavin, pyridoxine (vitamin B-6) and pantothenic acid. These vitamins are essential in the sense that body requires them from external sources to replenish. These B-complex groups of vitamins help in enzyme synthesis, nervous system function and regulating body metabolism. Mustards are rich source of many health benefiting minerals. Calcium, manganese, copper, iron, selenium and zinc are some of the minerals especially concentrated in these seeds. Calcium helps to build bone and teeth. Manganese is used by the body as a co-factor for the antioxidant enzyme superoxide dismutase. Copper is required in the production of red blood cells. Iron is required for the red blood cell formation and

cellular metabolism. Mustard seeds and its oil has traditionally been used to relieve muscle pain, rheumatism and arthritic pain. The mustard oil is applied over scalp and is believed to stimulate hair growth. Its ground seeds act as a laxative, stimulant to gastric mucosa and increase intestinal secretion (Sarwar et al., 2009; Sarwar, 2004a, b).

The protein quantity and quality, caloric value, and overall nutrient content of oilseeds are quite good. In many new oilseed protein sources, phenolic compounds are as important as unsaturated lipids, carbonyl compounds, and nonenzymatic browning in the development of adverse flavors and colors in food products. The free phenolic acids are of particular concern because of enzymatic oxidation to quinones and subsequent binding to lysine and methionine in the proteins. Numerous free phenolic acids have been identified in all oilseed flours with syringic, ferulic and vanillic being the major components in cottonseed, peanut and soybean flours. Gossypol in cottonseed, chlorogenic acid in sunflower, and sinapine in rapeseed are microconstituent phenolics which cause unique problems in the utilization of these defatted flours and their protein isolates in food applications. The roles of bound phenolics and tannins in the binding of essential nutrients or altering chemical and functional properties require further investigation (Sosulski, 1979).

The Cucurbitaceae seeds such as *Cucumeropsis mannii*, *Cucurbita maxima*, *Cucurbita moschata*, *Lagenaria siceraria* and *Cucumis sativus* and their defatted cakes are rich in proteins (28 to 40.49% and 61 to 73.59%, respectively). They also contain high lipid levels similar to those of the other oilseeds. These seeds can thus be considered as sources of proteins and oils (Mercy et al., 2005). Oilseeds and their constituents developed as functional foods or as sources of nutraceuticals provide benefits for consumers and food processors, and represent a significant opportunity for biotechnology and plant breeding companies. Researchers are applying molecular biology and biotechnology approaches to produce soy and canola oils enriched with sitosterols (Kishore and Shewmaker, 1999). Vegetable oils containing 2 to 5% phytosterols/stanols have been generated by expressing the gene encoding the rate-limiting enzyme for sterol synthesis, hydroxymethylglutaryl-CoA reductase, in seeds of crop plants (Venkatramesh et al., 2000).

Oilseeds are high in phytic acid and contain fiber and perhaps other binding agents which reduce mineral bio-availability from the seeds. Phytic acid, the hexaphosphate of myoinositol, functions as the chief storage form of phosphate and inositol in mature seeds. On a dry basis, whole oilseeds contain about 1.5%, while some oilseed protein concentrates can contain over 7.0% of the compound. Phytic acid is a strong chelating agent that can bind mono- and di-valent metal ions to form the complex phytate. Published results from numerous

animal feeding trials suggest poor bio-availability of minerals such as zinc, calcium, magnesium, phosphorus and possibly iron from diets containing high phytate foods. Recent studies involving the feeding of soy products to rats suggest that zinc is the mineral of most concern as its bio-availability from some soy products is quite low. Prediction of mineral bio-availability from phytate-containing foods is complicated by the complex interactions between the minerals and phytic acid contained in the foods, intestinal and the meal phytase activities, previous food processing conditions (especially pH), digestibility of the foods as well as the physiological status of the consumer of the foods. Very little is known about the chemistry of such interactions. Therefore, most of the emphasis in controlling or reducing mineral binding in oilseed products has been placed upon development of methodology for phytate removal (Erdman, 1979; Sarwar et al., 2011b). Nutritional research itself has a tremendous impact on the development and successful commercialization of modified vegetable oils. As the category of natural health products and functional foods develops, it is clear that there will be a significant role for fats and oils in formulating and developing products that will maintain well being and reduce the risk of disease.

CONCLUSION

This article reviews the main types of oilseeds; their production and processing into oil. It focuses on the role of oilseeds and their by-products in human health and disease, and highlights new developments that may provide even more benefits for health in the future. Improving oilseed meal characteristics will continue to attract considerable attention. There are two general approaches, one focuses on the processing step, the other involves altering the composition of the oilseed using plant-breeding technologies. A result of such activities, on ongoing change in the nutritional characteristics of the oilseed meals should be made available to the market. This will result in new competitive pressures, which ultimately encourage greater efficiencies in the sectors involved. Historically, food nutritionists should quickly learn how to maximize their use of new 'co-products' and other ingredients as they became available to the market. Our dietary intakes comprise three macronutrients (protein, carbohydrate and lipid) and a large but unknown number of micronutrients (vitamins, minerals, antioxidants, etc). Good health rests, in part, on an adequate and balanced supply of these components especially through oilseeds. Oilseeds also deliver environmental benefits, including reduce of

nitrogen leaching and soil erosion, provide pollen for bees, a food source and habitat for a range of wildlife.

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