Applications and Potential of Oilseed Crops

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Oilseeds have proven to be the backbone of agricultural economy in India as they are the second most important crop, after cereals within the segment of field crops (Parmar et al. 2013). Edible oilseeds crops are obtained from various primary and secondary sources. Among these, the nine primary crops includes, soybean (glycine max), groundnut (*Arachis hypogaea*), rapeseed & mustard (*Brassica*) contributes to more than 88% of total oilseeds production (Yadav et al. 2018). More than 80% of vegetable oil is contributed by mustard (35%), soybean (23%) and groundnut (25%) crop itself. In addition to these crops, oil harnessed from secondary sources like cottonseed, rice bran, coconut, Tree Borne Oilseeds (TBOs) and Oil Palm is also popular in India (Singh et al. 2017). Lipids are the main reserved form of energy in the embryo of oilseeds, which is most efficient compound in terms of energy in comparison to carbohydrates or proteins. Quality of oil seeds is determined by its fatty acid composition, antioxidants (tocopherols, carotenoids and phenolic compounds) etc (Izquierdo et al. 2017). Also, the genetic constituent and growing conditions have strong impact on the quality parameters of the seeds and thereby influencing their commercial value (Mailer and Beckingham 2006). Some oilseeds crops have high oil concentration (sunflower, mustard) while for other crops oil is a co-product (cotton, maize, rice).

The revolution launched in 1986-1987 to achieve self-reliance in edible oils, with special emphasis on four crops (mustard, groundnut, soybean and sunflower). The revolution led to doubling of the India's oil production (from 12 million to 24 million tonnes) within ten years. This increase in the production may be attributed to processing facilities (hybrid seeds, irrigation, fertilizers, pesticides, transportation facility, minimum support price and warehousing) provided to the farmers (Kumar and Tiwari 2020). However, the self-sufficiency attained through yellow revolution was for a short period. Despite being one of the largest oilseed crop producing country in the world, India is not able to meet the spurt in vegetable oil consumption and industrial usages (Rani and Singh 2022). India accounts for 10% of the global oilseed production with 20.8% of the area under cultivation (Renjini and Girish 2019). Oilseed production through the years increased from 108.3 (in 1985-86) to 365.65 (in 2020-21) lakh tonnes with major contribution from Rajasthan, Maharashtra, Gujarat, Madhya Pradesh, Uttar Pradesh, Haryana and Andhra Pradesh. India is also one of the major oilseed exporter (mustard, soybean, cotton seed, sunflower, sesame and groundnut). The oil is being exported to USA, Netherlands, China, Australia, Singapore, Belgium, Germany, Indonesia, Hong Kong, Nepal, Saudi Arabia and Italy (Thappa et al. 2019).

Oilseeds are among the five essential ingredients of human diet other than protein, carbohydrates, minerals and vitamins (Chandrasekaran and Shine 2012). The major components of vegetable oils comprise of triacylglycerols and other minor components includes phospholipids, sterols, antioxidants, mono and diacylglycerols (Abiodun 2017). The oils consist of long-chain fatty acids [C-14 to C-24] that may be saturated, monounsaturated or polyunsaturated.

Recently, human diet has witnessed increment in unsaturated fatty acids (C18:1; C18:2 and C18:3) due to their health benefits (Mailer, 2004). Therefore, altering the fatty acids composition of traditional oilseed crops has been area of interest for plant breeders.

Applications of oilseed crops

A wide variety of bioactive compounds have been obtained from oilseeds. Apart from their role in human diet, oilseeds have several industrial applications in biodiesel, fertilizer, medicine, soaps, skin products, animal feeds, fibers, candles, perfumes, paint, button etc (Zhang et al. 2023). Due to the nutrient enriched by products (hull, meal and oil) of oilseed crops had also been integrated into animal diet.

1. **Fuel:** Agro waste from oilseed crops has the potential to be used as source of renewable energy hence supporting the evergreen biofuel industry (Neupane 2022). Oilseed crops are characterized as source of biodiesel, an alternative fuel in the industry. Positively the production of biofuels is feasible at low price, however the disadvantage is the prevalence of fuel over food (Balat 2011). Hence, over the past few years, non-edible oilseed crops have been emphasised upon for biofuel production (Lu et al. 2011). The highest biodiesel yield is given by palm oil followed by coconut, rapeseed, peanut, sunflower and soyabean oil. Genetic engineering has been applied to transform the traditional plants for desired oil content (Waseem et al. 2017).
2. **Fertilizer:** Oilseed meals are used as organic nitrogen fertilizer and weed control agents for example, Brassica species have higher nutrient quality in comparison to sunflower seed meal (Mazzoncini et al. 2015). Also, the Brassica seeds through enzymatic activity of glucosinolates are effective in controlling weeds, insect pests and other nematodes. The presence of toxic allergen such as ricin in castor meal has proven to be useful as it's toxic for the microorganisms (Nangbes et al., 2013).
3. **Food industries:** Higher concentration of free radicles in the human body are harmful as they initiate unwanted oxidation reactions (Packer and Ong 1998). The easiest way to inhibit these processes is the addition of antioxidants directly into the diet. The major natural antioxidants present in vegetable oil includes tocopherols, tocotrienols, carotenoids, flavonoids and some minute quantities of sterols and lignin (Kamal-Eldin and Appelqvist 1996). Hence, seed oil is being used for baking, as flavouring agent in margarines and salad dressing (Agarwal et al., 2003). Also, the meal of some oilseeds may be used to fortify food items e.g., coconut meal used to fortify food formulations as it has high dietary fibre that aids to the digestion (Madhavan et al. 2010).
4. **Animal feeds:** Oilseed meals although being underrated have proven to be biggest innovation in animal feeding. Oilseed meal is the by-product obtained after the refining and processing of oilseeds that have abundant energy as well as minerals and vitamins (McKevith 2005). The major crops used for this purpose includes soybean, mustard, peanut, sunflower and others (Zhang et al. 2023). In addition to high protein content, soybean meal also contains some antioxidants such as syringic, vanillic, ferulic, salicylic and sinapic acids. Rapeseed meal on the other hand

contains sinapine, benzoic and cinnamic acid derivatives, phenolic acid esters and glycosides (Schmidt and Pokorny 2005).

5. **Enzymes:** In solid state fermentation oilseed meal have been used as substrate for the production of enzymes (Chatterjee 2015). Various enzymes such as tannase, inulinase, lipase, mannose, amylase, L-glutaminase and protease have been produced using several bacterial and fungal strains (*Candida rugosa, P. chrysogenum).* Several antibiotics have also been produced from oilseed meals (soybean, sunflower and sesame oil meal) e.g., cephamycin C and clavulanic acid (Usman and Saif 2023).
6. **Other Products:** Some fatty acids in oilseed crops are beneficial for the skin such as linoleic and oleic acids. Linoleic acid prevents the hyperpigmentation caused by ultraviolet rays hence is used for treating dermatomes or sunburns (Lautenschläger 2003). Oleic acid help regulate the percutaneous lipid barrier of the skin hence, helps to fight against redness, itchiness and skin sensitivity (Vermaak et al., 2011). Coconut oil has proved to be good moisturizer for hair and skin as it contains antioxidants as well as antibacterial properties (Madhavan et al. 2010b). Soybean and palm kernel oil for making soaps, detergents and toiletry products. Linseed oil (non-food crop) has found it's way in textile industry as it becomes hard and elastic on drying therefore used for manufacturing of paints, resins or printing inks (Abiodun 2017).

Conclusion

Oilseed crops have been backbone of agriculture as they provide us edible products, act as substrate for biofuel production and several other industrial applications. However, the production of oilseed crops is not able to meet the demand of ever rising population in India. So, breeders are focusing to optimize the characteristics of traditional crops to achieve desired levels of production. The changes introduced include higher oil content, changes in fatty acid profiles and the reduction in antinutritional components. Further, there is scope in exploring the oilseed meal benefits in food fortification that can help mitigate the food insecurities.

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