PlantArchives Volume 20 No. 2, 2020 pp. 8486-8490 **e-ISSN:2581-6063 (online),ISSN:0972-5210**

DIFFERENT SEEDS IN FOOD INDUSTRY: HEALTH BENEFITS AND INDUSTRIALAPPLICATIONS

Savita Bhardwaj[1#], Bharat Kapoor[2#], Yendrembam K. Devi[3] and Dhriti Kapoor[1*]

[1*]Department of Botany, School of Bioengineering and Biosciences, Lovely Professional University, Delhi-Jalandhar Highway, Phagwara (Punjab), India.

[2]Department of Tourism and Hospitality, Guru Nanak Dev University, Amritsar (Punjab), India.

[3]Department of Entomology, School of Agriculture, Lovely Professional University, Delhi-Jalandhar Highway, Phagwara (Punjab), India.

 # Contributed Equally

Abstract

Good health comes from good diet is a well-recognized fact by consumers. Lipids are crucial constituents of the human diet therefore, have significant benefit to consumers and food industry. Seed oils are one of the important parts of the human diet due to the occurrence of important essential oils, tocopherols and phytosterols. Chia seeds, flaxseeds and sunflower seeds have gained the attention of nutritionists and are emerging plant-derived nutraceuticals because of presence of various constituents *i.e.* dietary fibre, proteins, vitamins, omega-3 fatty acids, antioxidants, phenolic compounds and indispensable nutrients and recognized as important functional foods, use to make products as seed and oil to supplement foodstuffs with linolenic acid. This review mainly provides an insight into role of different seeds in food industry; their health benefits and industrial applications.

***Key words*:** Health, diet, nutraceutical, functional food.

Introduction

Food security occurs when whole population have appropriate, secure and nutritive diet that fulfills their dietary prerequisite and food desire for vigorous growth, well maintained physical, communal and economic lifespan (Prathyusha *et al.*, 2019, Panghal *et al.*, 2018; Pandey *et al.*, 2019; Iid *et al.*, 2020). Presently, the need of healthy life is elevating the exploration for functional foods and nourishing food stuffs that are associated with good vigor (Ullah *et al.*, 2016; Srivastava *et al.*, 2014; Kumar *et al.*, 2020). Food industry companies have greater requirement of food products that can fulfill the need of consumers for a vigorous life (Pinakin *et al.*, 2018; Sharma *et al.*, 2020). In this context, functional food appears as an important asset that not only decline malnutrition and provide essential nutrients but also enhance consumers physical and mental health and stop nutrition-linked ailments (Menrad, 2001; Nagpal *et al.*, 2012; Chhikara *et al.*, 2019) and these foods also appear as resourceful and promising assets to deliver fitness profits (Hao and Beta, 2012; Rosma *et al.*, 2016).

***Author for correspondence :** E-mail: dhriti405@gmail.com

Salvia hispanica L. frequently acknowledged as chia, is an annual oilseed herbaceous crop, belongs to the family Lamiaceae, indigenous to the Mexico and northern Guatemala (Ixtaina *et al.*, 2008). Chia seeds are recently considered as imperative part of human diets and are progressively consumed all over the globe because of their nutritional composition (Melo *et al.*, 2019) and considered as a beneficial agricultural crop. Chia seeds are used as a dietary supplement and continuous efforts are made by researchers to promote it as functional food due to the occurrence of alpha linolenic acid in it (Gazem and Chandrashekariah, 2016).

Linum usitatissimum normally called as flaxseed, is a prehistoric imperative global annual herbaceous seed crop belonging to the Linaceae family. Flaxseed is consumed by people all around the globe from the early period of the ancient civilizations (Rubilar *et al.*, 2010). Flaxseed is widely used in functional foods (Yasmeen *et al.*, 2018) and taken either as diet moiety or as an additive to make food products (Panaite *et al.*, 2017; Kaur *et al.*, 2019) because of its exceptionally high content nutritional composition *i.e.* α-linolenic acid (Singh *et al.*, 2012), dietary fiber, proteins, phytoestrogens and due to its

beneficial pharmaceutical value (Gutte *et al.*, 2015). *Helianthus annuus* commonly known as sunflower, belongs to the Asteraceae family is a profitable agricultural crop and its seed oil is among the utmost required oils in all around the globe (Kumar and Thakur, 2014: Salas *et al.*, 2015).

Different seeds used in food industry

Chia seeds

Chia seeds have great impact on people who take it in diet routine and are recognized as super nutritional foods (Sreeremya, 2017). The chia is major oilseed crop which contains high amounts of ω-3 fatty acids, gluten free protein, dietary fibre, vitamins (Vitamin B1, B2, B3, B9, Vitamin C and vitamin A), minerals (calcium, phosphorus, potassium and magnesium), wide range of polyphenolic compounds *i.e.* chlorogenic acid, protocatechuic acid, gallic and p-coumaric acids,

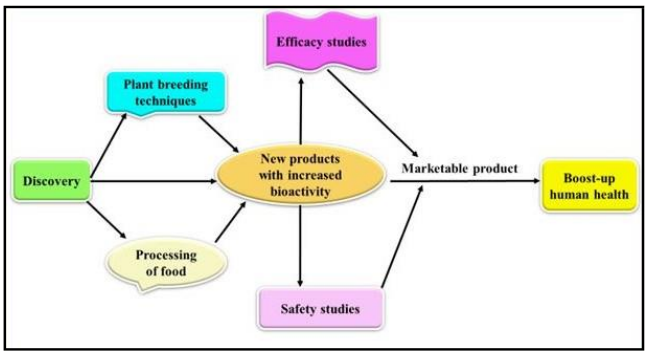

Fig. 1: Schematic representation of designing of functional foods.

quercetin, caffeic acid, rutin, apigenin, kaempferol, myricetin and antioxidants (Cahill, 2003; Ullah *et al.*, 2016). The proportion of protein, fat, carbohydrate and dietary fibre ranged from 15 to 25%, 30–33%, 41%, 18-30% respectively in chia seeds (Ixtaina *et al.*, 2008).

Chia seed recognition as a brand-new diet by the European legislature caused greater application of it in variety of foods and also have therapeutic properties by producing high amounts of essential oil that is used for the manufacture of ω-3 capsules (Ullah *et al.*, 2016). Chia seeds are consumed as entire, pulverized and also as gel and oil and consumed as alternatives for eggs and fat due to the hydrophilic nature of seeds (Felisberto *et al.*, 2015; Ding *et al.*, 2018; Gallo *et al.*, 2018). 25% level of substitution of oil or eggs in cakes by Chia seed gel has an beneficial appearance on sensory facets of the product for instance color, taste, and texture butat 50–75% level of substitution of oil in bread, adversative alteration was detected in concentration and inclusive superiority of the baked foodstuffs (Borneo *et al.*, 2010). Chia seeds flour also appeared as a moiety to prepare pasta in place of wheat flour and they evaluated that pasta made with a proportion of chia flour had a more nutritive value in comparison to those who prepared with wheat flour alone, attributed to the occurrence of greater levels of protein, nutrients and dietary fibre and also found that pasta with 7.5% level of chia flour displayed admirable nutritional properties and acknowledged as the maximum acceptance index in the matter of flavor (Oliveira *et al.*, 2015).

Gruel prepared from chia seeds also used for manufacture of ice-cream as a substitute of emulsifiers and stabilisers. Gluten-free, ω-3 and fibre rich chips are made from chia flour when taken in various ratios *i.e.* 5%, 10%, 12% and 15% and found that chips made from 5% of flour had maximum consumer acceptability (Campos *et al.*, 2016). Chips made with 5% of flour showed no deviation in the taste, color, flavor, texture and inclusive fondness of the product in comparison to commercially prepared chips (Coorey *et al.*, 2012). Chia mucilage can also be used to prepare breads and chocolate cakes which can supersede up to half proportion of fat without altering the overall attributes of the product and this chia mucilage is a novel substitute for replacing fat from foodstuffs and useful for maintaining overall nutritional and quality characteristics of food products (Fernandes and Salas-mellado, 2017).Recently, use of chia seeds into milk commodities such as curd and ice-cream has also enhanced (Chavan *et al.*, 2017).

Flaxseed

Presently, flax seeds are seeking attention of scientific and medical journals because of presence of several medicinally and biologically important active constituents hence, considered to being termed as quintessential functional food (Koz³owski *et al.*, 2014) and recognized as functional food due to occurrence of three important active constituents i.e. α-linolenic acid, lignans and dietary fibre (Verma *et al.*, 2017). Flaxseed contains high amounts of polyunsaturated omega 3 and 6 fatty acids,

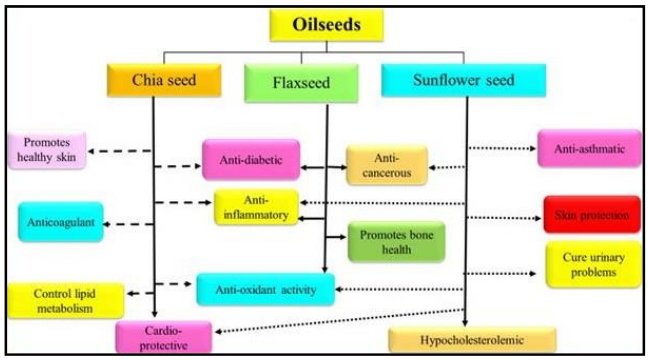

Fig. 2: Diagrammatic representation of health benefits of oil-seeds.

mucilage, polyphenolic compounds, natural waxes, vitamins (A, B, E), minerals, squalene, protein, lignan, oil and soluble fibre (Zhang *et al.,* 2008; Sharma *et al.,* 2019). Processing of linseed to manufacture various industrial products, not only makes it a vital crop for humanity but is also recognized as the bio-economy crop of the recent decade (Kaur *et al.,* 2018).

The increasing demand of flaxseeds as functional food caused enhancement in the consumers requirement for its foodstuffs and it is regarded as functional food and nutraceutical due to flaxseed low ω-6/ω-3 proportion. Recently, they are used in making cakes, multigrain breads, organic products, salad dressings, soups, biscuits, crackers and in ready-to-eat breakfast cereals and drinks (Coskuner and Karababa, 2007; Ayelign and Alemu, 2016) and is also used in dairy products, curd, and bread toppings and also traded as soft-gel capsules as a diet moiety (Dunford *et al.*, 2015). Flaxseed is incorporated as a nourishing moiety in making bakery products and in making some dietary products (Yasmeen *et al.,* 2018). In United States, its flour is practiced industrially to manufacture bread. In Ethiopia, its seeds are generally cooked, pulverized, combined with condiments and H_2O, served with Injera and breads, used for preparing food, edible oil and also taken as porridge and beverage known as chillika (Negash *et al.,* 2012). Flaxseed meal is gluten free and its protein amount along with the gelling or binding characteristics of its soluble fibre is used for making gluten free baked products or thickening agent and also attributed as a moiety to prepare baked foodstuffs instead of eggs (Eyres and Eyres, 2014).

Sunflower seed

Helianthus annuus L. is a useful oilseed crop cultivated all around the globe (Kandakov *et al.,* 2012) and have various medicinal properties making it a nutritious food and medicine globally. Sunflower seeds contain high amounts of mineral nutrients, antioxidants, vitamins, unsaturated fats, proteins, dietary fibres, selenium, folate, and various phytochemicals. Sunflower seed oil has moderate taste, light color, and high oxidative firmness hence, recognized as a quality oil which is used to make several foodstuff products and these products have high nutritious value due to the seed processing technology. There is a large amount of crude protein and ether extract in sunflower cake which is left after its oil extraction (San and Villamide, 2000). When sunflower cake (10 and 20%) is used for making chapatti's and biscuits, there is a noteworthy enhancement in the amount of protein, fat and fiber values (Srilatha and Krishnakumari, 2003). Incorporation of sunflower seeds to different amounts in bread enhanced the flavor, taste and the overall nutrient profile of the bread and can substitute wheat flour up to 16% (Skrbic and Filipcev, 2008). Oil of sunflower seeds is sold for retailing and domestic eating, for instance, in industry, it is extensively used for frying (snack foods), encapsulation of volatile oils and flavor compounds, formulation of emulsions, sauces and margarines and also an admirable flavor carrier (Dunford, 2016).

Conclusion

Functional foods are one of the utmost, promising and vigorously evolving aspect of food industry (Patel, 2013). Consumers demand for oilseeds (chia, flaxseed and sunflower seed) as food products such as breads, cakes, cookies, cereal bars and many more, for healthy benefits has elevated due to various food industry applications. The nutritional aspects of these seeds can be improved for increasing its consumption in daily diet to both international commodities and rural population. Due to the presence of several beneficial nutrients in seeds of chia, flaxseed and sunflower, their cultivation should be improved in agriculture and worldwide. Growing these oilseed commodities into staples are proposed to retrieve population from succumbing to starvation.

References

Ayelign, A. and T. Alemu (2016). The functional nutrients of flaxseed and their effect on human health: a review. *European J. Nutr. Food Saf.,* **6(2):** 83–92.

Borneo, R., A. Aguirre and A.E. León (2010). Chia (*Salvia hispanica* L.) gel can be used as egg or oil replacer in cake formulations. *J. Am. Diet. Assoc.,* **110:** 946–949.

Cahill, J. (2003). Ethnobotany of chia, *Salvia hispanica* L. (Lamiaceae). *Econ. Bot.,* **57:** 604–618.

Campos, B.E., T.D. Ruivo, M. Scapin, G.S. Madrona and R.C. Bergamasco (2016). Optimization of the mucilage extraction process from chia seeds and application in ice cream as a stabilizer and emulsifier. *LWT Food Sci. Technol.,* **65:** 874–883.

Chavan, V., K. Gadhe, S. Dipak and S. Hingade (2017). Studies on extraction and utilization of chia seed gel in ice cream as a stabilizer. *J. Pharmacogn. Phytochem.,* **6(5):** 1367-1370.

Chhikara, N., K. Kushwaha, P. Sharma, Y. Gat and A. Panghal (2019). Bioactive compounds of beetroot and utilization in food processing industry: A critical review. *Food Chem.*, **272:** 192-200.

Coorey, R., A. Grant and V. Jayasena (2012). Effects of chia flour incorporation on the nutritive quality and consumer acceptance of chips. *J. Food Res.,* **1(4):**.

Coskuner Y. and E. Karababa (2007). Some physical properties of flaxseed (*Linum usitatissimum* L.). *J. Food Eng.,* **78(3):**

1067-1073.

Ding, Y., H.W. Lin, Y.L. Lin, D.J. Yang, Y.S. Yu, J.W. Chen, S.Y. Wang and Y.C. Chen (2018). Nutritional composition in the chia seed and its processing properties on restructured ham-like products. *J. Food Drug Anal.*, **26:** 124-134.

Dunford, N.T. (2015). Hemp and flaxseed oil: properties and applications for use in food. Specialty Oils and Fats in Food and Nutrition; Woodhead Publishing, 39-63.

Dunford, N.T. (2016). Sunflower seed oil: a premium oil for food applications. 19th International Sunflower Conference, Edirne, Turkey, 117.

Eyres, L. and M. Eyres (2014). Flaxseed (Linseed) fibre-nutritional and culinary uses-a review. *Food New Zealand*, **14(2):** 26.

Felisberto, M.H.F., A.L. Wahanik, C.R. Gomes-Ru, M.T.P.S. Clerici, Y.K. Chang and C.J. Steel (2015). Use of chia (*Salvia hispanica* L.) mucilage gel to reduce fat in pound cakes. *LWT Food Sci. Technol.*, **63:** 1049–1055.

Fernandes, S.S. and M.D.M. Salas-mellado (2017). Addition of chia seed mucilage for reduction of fat content in bread and cakes. *Food Chem.*, **227:** 237-244.

Gallo, L.R.R., R.B.A. Botelho, V.C. Ginani, L.L. de Oliveira, R.F.R. Riquette and E.S. Leandro (2018). Chia (*Salvia hispanica* L.) gel as egg replacer in chocolate cakes: Applicability and microbial and sensory qualities after storage. *J. Culin. Sci. Technol.*

Gazem, R.A.A. and S.A. Chandrashekariah (2016). Pharmacological properties of *Salvia hispanica* (chia) seeds: a review. *J. Crit. Rev.*, **3:** 63-67.

Gutte, K.B., A.K. Sahoo and R.C. Ranveer (2015). Bioactive components of flaxseed and its health benefits. *Int. J. Pharm. Sci. Rev. Res.*, **31(1):** 42-51.

Hao, M. and T. Beta (2012). Development of Chinese steamed bread enriched in bioactive compounds from barley hull and flaxseed hull extracts. *Food Chem.*, **133:** 1320–1325.

Iid, I.I., S. Kumar, S. Shukla, V. Kumar and R. Sharma (2020). Putative antidiabetic herbal food ingredients: Nutra/ functional properties, bioavailability and effect on metabolic pathways. *Trends Food Sci. Tech.*, **97:** 317-340.

Ixtaina, V.Y., S.M. Nolasco and M.C. Tomas (2008). Physical properties of chia (*Salviahispanica* L.) seeds. *Ind. Crop Prod.*, **28(3):** 286–293.

Kandakov, A., B. Havrland, C. Ojog and T. Ivanova (2012). Sunflower market assessment in the Republic of Moldova. Engineering for rural development; *Jelgava*, 128-133.

Kaur, P., P. Sharma, V. Kumar, A. Panghal, J. Kaur and Y. Gat (2019). Effect of addition of flaxseed flour on phytochemical, physicochemical, nutritional and textural properties of cookies. *J. Saudi Soc. Agric. Sci.*, **18(4):** 372-377.

Kaur, P., R. Waghmare, V. Kumar, P. Rasane, S. Kaur and Y. Gat (2018). Recent advances in utilization of flaxseed as potential source for value addition. *OCL*, **25(3):** A304.

Koz³owski, R.M., A. Krêgielczak, D.G. Radu, A.I. Pag and C. Sîrghie (2014). Flax Seeds–Source of Biomedical and Food Products. *Mol Cryst Liq Cryst.*, **603(1):** 122-135.

Kumar, A., A. Kaur, V. Tomer, P. Rasane and K. Gupta (2020). Development of nutria-cereals and milk based beverage: Process optimization and validation of improved nutritional properties. *J Food Process Eng.*, **43(1):** e13025.

Kumar, A. and R.C. Thakur (2014). Nanomagnetites green synthesis assisted by sunflower oil. *Res. J. Pharm., Biol. Chem. Sci.*, **5(6):** 1053-1058.

Melo, D., T.B. Machado and M.B.P. Oliveira (2019). Chia seeds: an ancient grain trending in modern human diets. *Food Funct.*, **10(6):** 3068-3089.

Menrad, K. (2003). Market and marketing of functional food in Europe. *J. Food Eng.*, **56(2-3):** 181-188.

Nagpal, R., P.V. Behare, M. Kumar, D. Mohania, M. Yadav, S. Jain, S. Menon, O. Parkash, F. Marotta, E. Minelli and C.J.K. Henry (2012). Milk, milk products, and disease-free health: an updated overview. *Crit. Rev. Food Sci. Nutr.*, **52(4):** 321-333.

Negash, W., Z. Asfaw and H. Yibrah (2012). Linseed (*Linum usitatissimum* L.) ethnobotany and cultivation status in Ethiopia. *Int. J. Agric. Appl. Sci.*, **4:** 48-57.

Oliveira, M.R., M.E. Novack, C.P. Santos, E. Kubota and C.S. Rosa (2015). Evaluation of replacing wheat flour with chia flour (*Salvia hispanica* L.) in pasta. *Semin.Ciênc. Agrár.*, **36:** 2545.

Panaite, T., M. Ropota, R. Turcu, M. Olteanu, A.R. Corbu and V. Nour (2017). Flaxseeds: nutritional potential and bioactive compounds. *Bull. Univ. Agric. Sci. Vet. Med. Cluj-Napoca, Food Sci. Technol.*, **74(2):** 65-73.

Pandey, D., A. Kakkar, M. Farhan and T.A. Khan (2019). Factors influencing organic foods purchase intention of Indian customers. *Organic Agriculture*, **9(4):** 357-364.

Panghal, A., N. Chhikara, N. Sindhu and S. Jaglan (2018). Role of food safety management systems in safe food production: A review. *J. Food Saf.*, **38(4):** e12464.

Patel, S. (2013). Reviewing the prospects of Opuntia pears as low-cost functional foods. *Rev. Environ. Sci. Biotechnol.*, **12(3):** 223-234.

Prathyusha, P., B.A. Kumari, W.J. Suneetha and M.N. Sai (2019). Chia seeds for nutritional security. *J. Pharmacogn. Phytochem.*, **8(3):** 2702-2707.

Rosma, A., A. Singh, A. Ann, A. Raj, A. Gupta, A. Kumar, B. Thilakarathne, B. Neopany, D. Angchok, F.Y. Chye and G.F. Rapsang (2016). Indigenous fermented foods.

Rubilar, M., C. Gutiérrez, M. Verdugo, C. Shene and J. Sineiro (2010). Flaxseed as a source of functional ingredients. *J. Soil Sci. Plant Nutr.*, **10(3):** 373-377.

Salas, J.J., M.A. Bootello and R. Garcés (2015). Food uses of sunflower oils. Sunflower; AOCS press, 441-464.

San, J.L.D. and M.J. Villamide (2000). Nutritional evaluation of sunflower seeds and products derived from them. *Br. Poul. Sci.,* **41:** 182-92.

Sharma, M., K. Dadhwal, Y. Gat, V. Kumar, A. Panghal, R. Prasad, S. Kaur and P. Gat (2019). A review on newer techniques in extraction of oleaginous flaxseed constituents. *OCL,* **26:** 14.

Sharma, P., G. Kaur, B.A. Kehinde, N. Chhikara, A. Panghal and H. Kaur (2020). Pharmacological and biomedical uses of extracts of pumpkin and its relatives and applications in the food industry: a review. *Int. J. Veg. Sci.*, **26(1):** 79-95.

Singh, K.K., S.A. Jhamb and R. Kumar (2012). Effect of pretreatments on performance of screw pressing for flaxseed. *J. Food Process Eng.*, **35(4):** 543-556.

Skrbic, B. and B. Filipcev (2008). Nutritional and sensory evaluation of wheat breads supplemented with oleic-rich sunflower seed. *Food Chem.*, **108:** 119-29.

Sreeremya, S. (2017). Nutritional Aspects of Chiya Seeds. *Int. J. Adv. Res. Dev.,* 45-48.

Srilatha, K. and K. Krishnakumari (2003). Proximate composition and protein quality evaluation of recipes containing sunflower cake. *Plant Foods Hum Nutr.*, **58:** 1-11.

Srivastava, G., C.K. Das, A. Das, S.K. Singh, M. Roy, H. Kim, N. Sethy, A. Kumar, R.K. Sharma, S.K. Singh and D. Philip (2014). Seed treatment with iron pyrite (FeS_2) nanoparticles increases the production of spinach. *RSC Advances*, **4(102):** 58495-58504.

Ullah, R., M. Nadeem, A. Khalique, M. Imran, S. Mehmood, A. Javid and J. Hussain (2016). Nutritional and therapeutic perspectives of Chia (*Salvia hispanica* L.): a review. *J. Food Sci. Technol.*, **53(4):** 1750-1758.

Verma, R., R. Prasad and A. Gupta (2017). Functional properties and health benefits in flaxseed fiber and oil (*linum usitatissimum* L.). *Int. J. Home Sci.*, **3(1):** 368-9.

Yasmeen, M., S. Nisar, V. Tavallali and T. Khalid (2018). A review of phytochemicals and uses of flaxseed. *Int. J. Chem. Biochem. Sci.*, **13:** 70-75.

Zhang, Z.S., L.J. Wang, D. Li, S.S. Jiao, X.D. Chen and Z.H. Mao (2008). Ultrasound-assisted extraction of oil from flaxseed. *Sep. Purif. Technol.*, **62(1):** 192-198.