

easily made with this bland vegetable oil [7]. For use in mayonnaise, it should retain its natural yellow colour, but for oleomargarine, it should be colourless, for shortening and other plastic fats, it should contain an antioxidant. Peanut oil has also been experimented in weaning foods as a source of fat along with other ingredients [6]. Groundnut is used extensively for massaging polio patients. It is also used as a carrier of adrenaline in the treatment of asthma [9].

Composite flours - Groundnut cake flour is used to improve protein content and quality of several cereal-based food products in India, Kenya, Malawi, Nigeria, Senegal and Zimbabwe [7, 10]. In India alone, there have been several agriculture-products with groundnut as the protein-enriching medium. The partially defatted flour is used to improve the nutritional quality of various cereal-based products such as *gonfa*, millet (*Pennisetum glaucum*) based product and *epo-ogi*, a corn (*Zea mays*) based gruel. In Sudan, acceptable and nutritionally superior quality *kisra* is prepared from sorghum flour fortified with defatted groundnut flour [7]. The addition of defatted groundnut flour results in an improvement of baking ease, colour and texture of the final product.

Fortification with groundnut and subsequent fermentation improves the in vitro digestibility of the sorghum flour [21]. In developing countries where sorghum is a staple diet, there is a need to have a nutritional improvement programme on sorghum. Acceptable *gari*, a commonly used cassava-based Nigerian food, can be prepared with 15 percent defatted groundnut flour which showed an increase in the amount of protein and a remarkable increase in the concentration of all amino acids.

Protein isolates - The technology now exists for the production of groundnut proteins in the form of concentrates and isolates, which are acceptable for human consumption. Groundnut protein isolates are akin to soy protein isolates. Defatted materials obtained from oil extraction processes may be soluble in neutral to base reaction washes to extract much of the protein which subsequently separated from the whey formed by reducing the pH to isoelectrical levels. Isolates once separated are neutralized with alkali and may be spray dried.[16]

Groundnut cake or meal can be used for human consumption after partial hydrolysis of protein by fermentation using certain moulds. Such products are readily digestible and nutritious [17, 26]. Spray-dried groundnut protein isolate can be used to replace non-fat milk solids in the ice cream. Coprecipitated isolates containing protein (95%) can be prepared from various combinations of groundnut seed, cottonseed and soybean flours and rice flour [19]. Fortified milk systems were prepared by blending pasteurized whole milk with dried skim milk and groundnut protein isolate, to increase the TS to 15, 18, 20 or 23 percent. This was followed by processing at 80°C for 30 min and storage at 4°C for 24 hours. Curds were prepared by lactic culturing of the processed milk systems. Curd obtained from fortified milk showed an increase yield stress along with curd strength with enlarged concentration of added protein.

Fermented products - Groundnut cake are used after partial hydrolysis of the component protein by fermentation using certain moulds. Such products are readily digestible, tasty and nutritious. *Oncom* is a popular dish of Indonesia and can be prepared by pressing the kernels to remove oil. It is usually done by soaking the cake in water for 24 h and then draining it. High starch material such as cassava is added to it. It is then steamed, incubated with *Neurospora intermedia* or *Rhizopus oligosporus* and fermented for 1 to 2 days at 25 to 30°C after wrapping in banana leaves. It may be fried in oil or margarine and consumed [21].

Bakery products - Groundnut cake meal or defatted meal can be used to prepare bakery products with excellent organoleptic qualities [15]. Studies have shown that value added products like breads, biscuits, cookies and other products could be excellent vehicles for enhancing the utilization of groundnut protein especially in the diets of malnourished people in the developing countries [4].

Groundnut milk - Groundnut milk can be prepared by soaking kernels in 1 percent sodium bicarbonate (NaHCO₃) solution for 16 to 18 hours. The kernels are grounded in aqueous medium. The wet mass is steeped for 4 to 5 hour and filtered through cheesecloth to remove the product. In India groundnut milk called *Miltone*® is a commercial reality. *Miltone*® consists of groundnut milk extended with buffalo milk. It is prepared by adding shelled groundnuts to boiling water, removed from heat and is soaked for 7 minutes. It is then drained, deskinning. They are then soaked in 2% NaHCO₃ overnight. They are then rinsed with tap water; blend in warming blender with water (1:5 w/v) for 4 to 5 minutes. The homogenate is filtered through cheese cloth. Whey powder is added to the filtrate at 4% level (w/v), mixed thoroughly for 1 hour and boiled for 10 minutes to get groundnut milk [21]. Ground nut milk is usually fermented with *Lactobacillus acidophilus* and used as probiotic drink [11]

Peanut milk is one option to try if you follow a casein-free diet because, contrary to its name, it does not contain real milk. Sweeteners or seasonings such as cinnamon are also added. Peanut milk provides some nutritional benefits you won't get from cow's milk such as vitamin E, magnesium and vitamin B-6, and is packed with heart-healthy unsaturated fats [11].

Mishi - *Mishi* is concentrated, spiced yoghurt prepared from whole milk in Sudan and usually consumed along with bread. *Mishi* can also be prepared from peanut milk by boiling the milk for 3 minutes then cooling to 45°C and inoculating with yoghurt culture (1:1 mixture of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* grown in whole milk for 6 hours) at 5% level. This is then incubated at 45°C for 16 hours. Spices like garlic, ajwain and black pepper are added and refrigerated. Whey is drained through a cheese cloth and salt is added at 1% level [16].

Groundnut-based yoghurt - Groundnut yoghurt may be prepared by the pasteurization of groundnut milk containing 5 percent lactose. After cooling yoghurt culture is inoculated

and incubated at 37°C for 4h. Final product before consumption may be refrigerated .

Groundnut Dahi – The nutty flavour in peanut milk is due to the hexanal compound which is generated by the action of lipoxygenase on fatty acids. Dr. R. T. Patil and his team at the Central Institute of Post Harvest Engineering and Technology (CIPHET) under ICAR has developed a commercially viable process for the inactivation of lipoxygenase enzyme [12]. This was coupled with use of modern airless grinding and de-odourising technique. By using such prepared peanut milk, highly acceptable chocolate/vanilla flavoured beverages have been developed with about 12% total solids and 3.25% protein. The process for the preparation of acceptable curd (Dahi) with 15 % total solids and 4.25 % protein has also been optimized. .

Groundnut bars - The formulation contains 72 percent finely ground groundnuts, 12 percent maltose syrup, 9.5 percent finely ground sugar, 3 percent roasted desiccated coconut, 2 percent finely ground rice, 1 percent roasted sesame (*Sesamum indicum*) seed and 0.5 percent salt [25]. The ingredients are mixed at 60°C and passed through a peanut-butter mill. The mixture is pressed into a rectangular-shaped mould.

Groundnut butter - Commercial manufacture and consumption of groundnut butter is largely an American art. Groundnut butter is mainly used as a spread for bread or biscuits, in sandwiches, in candies and frostings or icings. It is a fair source of calcium, iron, thiamine, riboflavin and excellent source of niacin. Manufacture of groundnut butter involves roasting for controlled browning at 160°C for 40 to 60 minutes; cooling to stop the cooking process; blanching to remove the skins (testa); and then graded to remove light, scorched or discoloured kernels [21]. Addition of salt, stabilizers and other optional ingredients including sweeteners are measured and blended with the butter prior to cooling and packaging. Other additives include hydrogenated oil, antioxidants, honey, lecithin, whey.

Groundnut cheese - Cheese like products have been made from groundnut like protein isolate just as cheese is made from cow's milk. It has good quality protein, is easily prepared and low in cost. It is being used for "Mixed" feeding of undernourished groups in the developing countries [21]. A processed cheese spread has been prepared from groundnut protein based tone milk in India. It has a smooth consistency and milky flavour.

Tofu (curd) - Tofu from groundnut is a famous product in China and Japan. Soaking the groundnut kernels overnight and grinding into an emulsion may prepare it. The emulsion is boiled and filtered. The curd may be precipitated from the resulting fluid by adding calcium or magnesium sulphate. The product is left to settle and transferred to boxes lined with cloth filters or spread on trays. It may be sold as slices or slabs, curd is served in soup; the wet curd can be deep fried in oil [11].

Groundnut sweets - In India, groundnut is used to prepare *laddu* and *chikki*. To prepare *laddu*, groundnut kernels are roasted and seed coat is removed, the separated cotyledons

are mixed with thick, hot jaggery syrup. Small portions of the mixture are pressed to balls or *laddus*. *Chikki* is very popular product in Western India. It is prepared by mixing roasted and decorticated groundnut kernels with hot slurry of sugar. The mixture is spread in a thick layer on a tray or similar flat surface and then cut into small pieces on cooling. Roasted groundnuts are also used in the preparations of various other traditional Indian recipes such as *khichadi*, *guradani*, *barfi* and vegetable curries [14].

National Institute for Nutrition, Hyderabad, India has introduced a sweet prepared by groundnut, jaggery and wheat flour with low fat and high energy, named *Suruchi* [14]. The product was tested on the school children for its calorific value and consumer acceptance. The United Nations Development Programme (UNDP), in partnership with the Food and Agriculture Organization of the United Nations (FAO), in collaboration with the Technology Mission on Oilseeds and Pulses Ministry of Agriculture has published a "Culinary Preparations with Groundnut" of 42 delicious preparations with groundnut with the intent to promote groundnut as food crop for sustained nutritional security [25].

Partially defatted groundnuts – The preparation procedure involves removing the oil from the groundnuts and then reconstituting and roasting the kernels. Roasted groundnut kernels without skins contains high percent of protein, oil and carbohydrates along with many essential minerals and vitamins. This process consists essentially of simple mechanical operations: i.) pressing ii.) reconstitution and iii.) drying and roasting, either raw (with skin) or blanched groundnuts are hydraulically pressed to remove the desired amount of oil. The pressed groundnuts are boiled in water to expand them and to restore their original shape and size. Salt and other ingredients can be added during the expansion step. The expanded groundnuts are then dried and roasted [22].

Groundnut protein film - Groundnut protein film is one of the alternative edible films that can be used in an intermediate moisture food (IMF) due to its promising characteristics: bland flavour, low oxygen permeability and its ability to incorporate antimicrobial agents. A study proved that the predicted sorbic acid profile in coated food showed that groundnut protein might be used to retard sorbic acid migration from surface to food core and extend the product shelf life [13].

Value-added peanut based nutraceuticals - Peanut skin has low economic value despite the high content of antioxidants such as phenolics and can be an inexpensive source of antioxidants for use as dietary supplements. Peanut skins are obtained by direct peeling, blanching, and roasting. Total phenolics (TPs), total antioxidant activity (TAA) and free radical scavenging capacity of peanut skin extracts were determined by Yu and co workers [28]. High free radical scavenging capacities of peanut skin extracts were observed with high vitamin C.

5. Conclusion

Groundnut is also consumed directly and is used in processed food and snacks. Approximately one-third of world production is used in the confectionery products. Utilization of oil, meal and confectionery groundnuts are all increasing concurrent with a gradual shift away from oil and meal into confectionery use.

Initiating strong programs can investigate the underlying functional components and properties of peanut by-products which in turn proves its potential as food and feed additive. Another important challenge is in the potential applications of byproducts with modern technology (such as superfine grinding technology, microwave-assisted and ultrasound-assisted technology) both directly as food or feed supplements for animal and human consumption, and indirectly, as potentially health promoting byproducts in the meat supply, to offset and replace the carcinogenic effects of chemical food additives. Problems with the world food supply remain a serious matter which is the main cause of hunger and malnutrition across the world. With that as background, the development of by-products from peanut industry will make a significant contribution in all these areas in the years to come.

References

- [1] Achaya KT (1990) Oilseeds and oilmilling in India. A cultural and historical Survey, Oxford and IBH publishing Co. Pvt. Ltd. Calcutta.
- [2] Achaya KT (1993) FAG/WHO Expert Consultation on Fat and Oils. www.fao.org/docrep
- [3] Ahmed EH and Young CT (1982) Composition, nutrition and flavour of peanuts. Peanut Science and Technology, American Peanut Research and Association, Yoakum, Texas, USA, pp. 655-658.
- [4] Bansal P (2013) Development of value added products using peanut flour for nutritional and health benefits. M.Sc. Thesis (Food and Nutrition). Punjab Agricultural University, Ludhiana, Punjab. 129p.
- [5] Bassey FI, McWatters KH, Edem CA and Iwegbur CMA (2013) Formulation and Nutritional evaluation of weaning food processed from cooking banana and supplementation with cowpea and peanut. *Food Sci. Nutr.* 1(5): 384-91.
- [6] Chinnan MS (2011) Peanut Further Processing. Department of Food Science and Technology, College of Agricultural and Environmental Sciences, University of Georgia, Griffin, p46
- [7] Desai BB, Kotecha PM and Salunkhe DK (1999) Groundnut protein product. In: Introduction science and technology of groundnut: biology, production, processing and utilization. Naya Prokash Publishers, New Delhi, India, pp 546-582
- [8] Devi KB, Vidhya R and Jaganmohan R (2013) Determination and Isolation of Protein from Different Fractions of Defatted Groundnut Oil Cake. *Afr. J. Plant Sci* 7(8): 394-400
- [9] FAO- Food and Agricultural Organisation (1994) Expert's recommendations on fats and oils in human nutrition. Fats and Oils in Human Nutrition: Report of Joint Expert Consultation, FAO Food and Nutrition Paper No. 57. 9
- [10] Fekria AM, Isam ASA, Suha OA and Elfadil EB (2012) Nutritional and functional characterization of defatted seed cake flour of two Sudanese groundnut (*Arachis hypogaea*). *Intl. Food Res. J.* 12: 629-37.
- [11] Giyarto, Djaafar TF, Rahaya ES and Utami (2012) Fermentation of peanut milk by *Lactobacillus acidophilus* SNP-2 for production of non-dairy probiotic drink. *Proceedings of 3rd International Conference of Indonesian Society for Lactic Acid Bacteria: Better Life with LAB: Exploring Novel function of LAB.* 9p.
- [12] ICAR- Indian Council of Agricultural Research (2009) Development of Groundnut based Flavoured Beverages and Curd. www.icar.org.in/un/node/588
- [13] Jangchud A, Parameswarakumar, Mallikarjunan MS, Chinnan H, YunYun, Anuvat, Jangchud P, Mallikarjunan and Hao YY (1999) Sorbic acid migration in an intermediate moisture food coated with peanut protein film, Annual International Meeting, Toronto, Ontario, Canada, 18-21 July, 1999. 23 pp.; ASAE Paper No. 996147; American Society of Agricultural Engineers (ASAE); St Joseph; USA
- [14] Kadam SS and Chauhan JK (1991) Utilisation of groundnut in India and scope for novel and alternative uses. Use of tropical grain legume: Proceedings of a Consultants Meeting, 27-30 March 1989, ICRISAT centre, India.
- [15] Kane LE, Davis JP, Oakes AJ, Dean LL and Sanders TH (2012) Value added processing of peanut meal. *J. Food Biochem.* 36(5): 520-31.
- [16] Kim N, KimYJ and Nam YJ (1992) Characterisation and functional properties of protein isolates from various peanut cultivars. *J. Food Sci.* 57(2): 406-10.
- [17] Lewis WE, Harris GK, Sanders TH, White LB and Dean LL (2013) Antioxidant and Anti-inflammatory effects of Peanut skin extracts. *Biomed. Life Sci.* 4(8A): 22-32.
- [18] Nautiyal PC (2002) Groundnut Post-Harvest Operations. In: PGO- Post Harvest Compendium, National Research Center for Groundnut, Indian Council of Agricultural Research, p127
- [19] Patee HE and Young CY (1982) Peanut Science and Technology, American Peanut Research and Education Society, Inc. Yoakum, Texas, USA
- [20] Purohit C and Rajyalakshmi P (2011) Quality of products containing defatted groundnut cake flour. *J. Food Sci. Technol.* 48: 26-35.
- [21] Singh B (1992) Aspects of groundnut utilization and possible improvements of Indigenous food in some countries of semi-arid tropical Africa. In Groundnut a Global Perspective (ed.)
- [22] Singh MP and Memon AH (1993) Harvest and postharvest technology scheme All India coordinated ICAR, Research Scheme, Faculty of Agricultural Engineering and technology, Gujarat Agricultural University, Junagadh, Gujarat, India.
- [23] Singh B and Singh U (1991) Peanut as a source of protein for human foods. *Plt. Food Hum. Nutr.* 41: 165-77.
- [24] Spadaro JJ (1979) Uses of defatted and partially defatted peanut flour. *J. Amr. Oil Chem. Soc.* 56: 474-75.

- [25] Sulochana BN, Bhargavi K, Reddy TY and Basu MS (2000) Culinary Preparations with groundnut. UNDP Sub-programme on "Promoting Groundnut as Food Crop for Sustained nutritional Security" Implemented by National Research Centre for Groundnut, Junagadh in Collaboration with Acharya NG Ranga Agricultural University, RRS, Anantpur, Andhrapradesh.
- [26] Tate RV, Chavan JK, Patil PB and Kadam SS (1990) Processing of commercial peanut cake into food-grade meal and it's utilization in preparation of cookies. *Plt. Food Hum.Nutr.* 40:115-21.
- [27] United Nations Children's Fund (UNICEF) (2007) Progress for children: A world fit for children statistical review- UNICEF, New York (http://www.unicef.org/progress_for_children/2007nb/index_41505.htm)
- [28] Yu JM, Ahmedna M, Goktepe I and Dai J (2006) Peanut skin procyanidins: Composition and antioxidant activities as affected by processing. *J Food Compos Anal* 19:364-371.

