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Review Article

Food Grade Oil Quality of Peanut (*Arachis hypogaea* L.)

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Abstract

High-oil crop peanut has about 50% edible oil content. Major components of fatty acids of peanut oil are unsaturated fatty acids (oleic acid and linoleic acid). Oxidative stability is an important factor in peanut process industry. High-oleic peanut contains ≥72% oleate and <8% linoleate and preferred by oil processors and consumers. High-oleic peanuts provide a spectrum of nutrients and have improved sensory properties and technological advances beyond conventional peanuts. Also relation of enviromental stress factors with quality are mentioned here below in this review.

Keywords: Peanut, *Arachis hypogaea* L., edible oil, quality, oleic

INTRODUCTION

The cultivated peanut (*Arachis hypogaea* L.) is globally an important oil and food crop (Hu et al., 2018). This high-oil crop has about 50% oil content, and crushed for oil or used as edible products (Wang et al., 2015). Oilseed crops produce high amounts of fatty acids stored as triacylglycerols in their seeds with a wide variation in composition. Variety and content of triacylglycerols affect nutrition and function of lipids (Dong et al., 2015). As a high-fat food, peanuts is containing high contents of protein and fatty acids. The major components of fatty acids of peanut oil are unsaturated fatty acids: oleic acid (C18:1) and linoleic acid (C18:2) (Liu et al., 2018).

Raw, sun-dried and roasted groundnut seeds were analyzed for composition and minerals by Ayoola & Adeyeye, (2010). Raw, sun-dried and roasted seeds contained 46.1%, 43.8% and 40.6% fat; 24.7%, 21.8% and 18.4% crude protein; 17.4%, 27.2% and 36.1% carbohydrate; 7.5%, 3.4% and 1.1% moisture; 2.8%, 2.4% and 2.4% crude fibre and 1.5%, 1.4% and 1.4% ash, respectively. There was a decrease in the compositions after exposure to heating. Also there was variations in the mineral contents of the seeds following heating. Raw, sun-dried and roasted seeds contained sodium (0.71%, 0.69% and 0.57%), phosphorus (0.68%, 0.65% and 0.69%). potassium (0.47%, 0.51% and 0.55%), zinc (0.44%, 0.42% and 0.50%), Iron (0.40%, 0.47% and 0.43%). Free fatty acid of raw, sun-dried and roasted groundnut oil were 1.18 g $100g^{-1}$, 0.89 g $100g^{-1}$ and 1.26 g $100g^{-1}$, acid values were 2.35 mg/kOH/g, 1.79 mg/kOH/g and 2.52 mg/kOH/g, peroxide value were 0.74 meq/ kOH, 0.60 meq/ kOH and 0.47 meq/ kOH; and refractive index were 0.25, 0.26 and 0.15. The roasted groundnut can be considered as a good source of valuable minerals, while the raw groundnut is a good source of protein with high nutrition value.

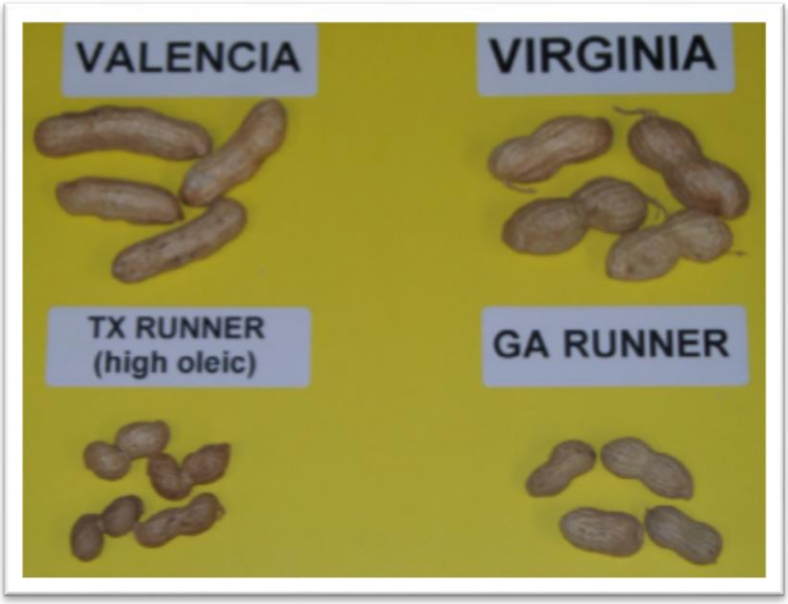

Fig. 1. Structural differences shown for various peanut types (Lewis et al., 2012).

Fatty acid profiles of commercial 10 Runner-type peanut cultivars collected during two production years were analysed by Shin et al., (2010). Eight different major fatty acids were determined: 1) palmitic (C16:0), 2) stearic (C18:0), 3) oleic (C18:1, ω9), 4) linoleic (C18:2, ω6), 5) arachidic (C20:0), 6) gondoic (C20:1, ω9), 7) behenic (C22:0), 8) lignoceric (C24:0) acids. According to the oleic / linoleic acid (O/L) ratio, selected peanut cultivars were found normal, mid-oleic and high-oleic types.

Antinutritional factors are substances found in most food substances which are poisonous to humans and in some ways limit the nutrient availability to the body. The groundnut oil and palm oil were extracted by soxhlet extraction method and compared for oxalate and phytate, tannin, trypsin inhibitor, cyanogenic glycosides, hemagglutinin and alkaloids by Inuwa et al., (2011). Groundnut oil was found containing higher concentration of the these anti-nutritional factors compared to palm oil.

Consumption of thermally oxidized oils have detrimental effects on different systems of the human body. Ani et al., (2015) compared the effects of consumption of thermally oxidized palm oil and thermally oxidized groundnut oil diets on selected haematological parameters on male albino Wistar rats. They demonstrated that thermally oxidized palm oil and thermally oxidized groundnut oil consumption may be detrimental to haematological systems. Effects were more in thermally oxidized palm oil fed group, than thermally oxidized groundnut oil fed group.

Mechanical expression could improve the yield and quality of groundnut oil. Yusuf et al., (2014) studied the effects of heating temperature and seed condition on the yield and quality of mechanically extracted groundnut oil. Oil yields increased by increases in temperature but decreased beyond 90^{o}C temperature. pH value, refractive index, specific gravity, peroxide value, free fatty acid values and total acid values of the oils decreased with temperature increases.

Oil were extracted from soabean, groundnut and coconut and processed for fatty acid analysis by Sodamade et al., (2013). Determined main saturated fatty acids were: 1) Palmitic acid (C16;O) was min (2.1%) in coconut oil and max (4.8%) in groundnut oil, 2) Stearic acid (C16;O) was min (1.5%) in soybean oil and max (12.1%) in groundnut oil. Monounsaturated fatty acid (Oleric acid, C18:1) was min (8.6%) in coconut oil and max (12.7%) in groundnut oil. Polyunsaturated fatty acid (Linoleic acid, C18:2, Omega-6) was min (5.7%) in soybean oil and max (9.2%) in groundnut oil. The major component of soybean and coconut oils was myristic acid (C14:O) (41.0% and 33.5% respectively). The highest component of groundnut oil was lauric acid (C12:O) at 14.6%.

High oleic acid peanuts

Peanut is nutrient-rich legume valued for its good quality cooking oil. The fatty acid content is the major determinant of the quality of the edible oil (Bera et al., 2019). Peanut oil is widely used in food but is susceptible to oxidation (Olmedo et al., 2018). Oxidative stability is an important factor in peanut process industry (Chamberlin et al., 2021). Less oxidation prone peanut type high-oleic peanut contains ≥72% oleate and <8% linoleate which is preferred by oil processors and consumers (Nkuna et al., 2021).

The nutritional quality, flavor, and shelf-life of peanut seeds and products depend on saturated, mono unsaturated fatty acid (MUFA) and poly unsaturated fatty acid (PUFA) content of its oils. High oleic peanut oils are highly valued due to superior nutritional composition for human health (Nawade et al., 2018). Unhealthy diets are significant risk factors for metabolic syndrome and associated gut microbiota disorders. High oleic acid peanut oil and extra virgin olive oil are healthy dietary oils which are rich in oleic acid and bioactive phytochemicals (Zhao et al., 2019). Peanuts contain bioactive nutrients beneficial for vascular function. Regular peanut consumption improved cerebrovascular and cognitive function; increased intakes of bioactive nutrients may have mediated these improvements (Barbour et al., 2017).

Customization of fatty acid profile of peanut is an evolving area to improve nutritional needs of modern markets (Nawade et al., 2016). 80% of peanut seed oil is either oleic or linoleic acid. The oleic / linoleic acid (O/L) ratio influences oxidative stability and peanut shelf life. O/L ratios of traditional peanut seeds is between 1.5–2.0; however, many new cultivars are ‘‘high oleic’’ with O/L ratios are greater than 9 (Davis et al., 2013). Peanut varieties with high oleic/linoleic acid ratios have become preferred by the peanut industry and many peanut breeding programs are incorporating high oleic trait into improved new varieties (Chamberlin et al., 2011). Modern peanut varieties contain fatty acid desaturase 2 (FAD 2) mutation which is producing high oleic acid (Liu et al., 2019).

High-oleic peanuts provide a spectrum of nutrients and have improved sensory properties and technological advances beyond conventional peanuts. High-oleic peanuts are not allergenic or less allergenic than conventional peanuts. High-oleic peanuts may also improve lipid profile and markers of glycemic control (Derbyshire, 2014).

Purity (% of high oleic peanuts within a lot) is important for ingredient performance and final lot value. Contamination can result from unintentional mix-ups at the breeder/seed level, improper production handling, or due to physiologically immature high oleic kernels. Therefore, industry groups have established unofficial sampling plans to monitor purity. Assuming equivalent measurement performance and simple random sampling, increasing the sample size decreases variance among replicated sample test results and increases the precision of estimated lot purity (Davis et al., 2021).

Agronomy

Groundnut is the sixth most important oilseed crop in the world and India is the second largest groundnut producing country. There is a need of increasing the production of groundnut and stabilizing its yield by using proper agricultural practices. Application of arbuscular mycorrhizal fungi has been considered as an important strategy for sustainable agricultural practices.

Pawar et al., (2018) evaluated effectiveness of 10 indigenous mycorrhizal species (*Glomus clarum, Glomus mosseae, Glomus fasciculatum, Glomus ambisporum, Glomus globiferum, Glomus intraradices, Gigaspora gigantea, Gigaspora albida, Acaulospora denticulata and Glomus pansiholus*) on groundnut oil. All mycorrhizal treatments produced significant results compared to non mycorrhizal plants. *Glomus mosseae* was superior to all ten mycorrhizal species. Extracted groundnut oil percentage for *Glomus mosseae* (41.7%) treated oil was higher than control (28.5%). Oleic acid, linoleic acid, palmitic acid content from groundnut oil of mycorrhiza treated plants varied in range of 36–45%, 16–22%, 13–18% respectively. Oil from *Glomus mosseae* treated groundnut plant showed increase in zinc, calcium, magnesium, manganese content than other mycorrhiza treated groundnut seed oil and control.

The level of oleic acid in peanut is genetically controlled by a pair of fatty acid desaturase genes, but the environmental conditions of the production sites can also have a significant effect. Analysis of gene and environment interaction revealed that oleic acid phenotype plasticity could be explained by the interaction of FAD2 genotype and photothermal time, which quantified environmental conditions (Tonnis et al., 2020).

Effects of rhizosphere temperature on oleic / linoleic acid (O/L) ratio, alpha, beta, gamma, delta tocopherols and total tocopherols, fructose, glucose and sucrose and the sum of fructose, glucose and sucrose contents in peanut kernels at seed filling period were studied by Haro et al., (2020). O/L ratio was increased with rhizosphere temperature increase. Mean O/L ratios were 1.31 and 1.20 for Florman and for ASEM, respectively. Total tocopherols contents were was similar for both varieties (478 ppm).

In the study of Chaiyadee et al., (2013), drought improved the oil quality by increasing oleic acid and O/L ratio and reducing linoleic acid, iodine value and unsaturated / saturated fatty acid ratio. Peanut genotypes with different levels of drought resistance displayed similar tendency in fatty acid characters under drought conditions.

CONCLUSIONS

High-oil crop peanut has about 50% edible oil content. Major components of fatty acids of peanut oil are unsaturated fatty acids (oleic acid and linoleic acid). Fatty acid compositions of peanut seed are important quality parameters due to affect on flavor, shelf life and consumer preference of derived food products. Oxidative stability is an important factor in peanut process industry. High-oleic peanut contains ≥72% oleate and <8% linoleate and preferred by oil processors and consumers. The oleic / linoleic acid (O/L) ratio influences oxidative stability and peanut shelf life. O/L ratios of traditional peanut seeds is between 1.5–2.0; however, many new cultivars are ‘‘high oleic’’ with O/L ratios are greater than 9. High-oleic peanuts provide a spectrum of nutrients and have improved sensory properties and technological advances beyond conventional peanuts.

REFERENCES

Ani, E. J., Nna, V. U., Obi, C. E., Udobong, N. J. 2015. Comparative effects of thermoxidized palm oil and groundnut oil diets on some haematological parameters in albino wistar rats. Australian Journal of Basic and applied sciences, 9(5): 181-184.

Ayoola, P. B., Adeyeye, A. 2010. Effect of heating on the chemical composition and physico–chemical properties of Arachis hypogea groundnut seed flour and oil. Pakistan Journal of Nutrition, 9(8): 751-754.

Barbour, J. A., Howe, P. R., Buckley, J. D., Bryan, J., Coates, A. M. 2017. Cerebrovascular and cognitive benefits of high-oleic peanut consumption in healthy overweight middle-aged adults. Nutritional neuroscience, 20(10): 555-562.

Bera, S. K., Kamdar, J. H., Kasundra, S. V., Patel, S. V., Jasani, M. D., Maurya, A. K., Varshney, R. K. 2019. Steady expression of high oleic acid in peanut bred by marker-assisted backcrossing for fatty acid desaturase mutant alleles and its effect on seed germination along with other seedling traits. PloS one, 14(12): e0226252.

Chaiyadee, S., Jogloy, S., Songsri, P., Singkham, N., Vorasoot, N., Sawatsitang, P., Patanothai, A. 2013. Soil moisture affects fatty acids and oil quality parameters in peanut. Internatıonal Journal Of Plant Productıon 7(1): 81-95.

Chamberlin, K. D., Grey, T. L., Puppala, N., Holbrook, C. C., Isleib, T. G., Dunne, J., Payton, M. E. 2021. Comparison of Field Emergence and Thermal Gradient Table Germination Rates of Seed from High Oleic and Low Oleic Near Isogenic Peanut Lines. Peanut Science, 48(2): 131-143.

Chamberlin, K. D., Melouk, H. A., Madden, R., Dillwith, J. W., Bannore, Y., El Rassi, Z., Payton, M. 2011. Determining the oleic/linoleic acid ratio in a single peanut seed: a comparison of two methods. Peanut Science, 38(2): 78-84.

Davis, B. I., Agraz, C. B., Kline, M., Gottschall, E., Nolt, M., Whitaker, T. B., Davis, J. P. 2021. Measurements of High Oleic Purity in Peanut Lots Using Rapid, Single Kernel Near-Infrared Reflectance Spectroscopy. Journal of the American Oil Chemists' Society, 98(6): 621-632.

Davis, J. P., Sweigart, D. S., Price, K. M., Dean, L. L., Sanders, T. H. 2013. Refractive index and density measurements of peanut oil for determining oleic and linoleic acid contents. Journal of the American Oil Chemists' Society, 90(2): 199-206.

Derbyshire, E. J. 2014. A review of the nutritional composition, organoleptic characteristics and biological effects of the high oleic peanut. International journal of food sciences and nutrition, 65(7): 781-790.

Dong, X. Y., Zhong, J., Wei, F., Lv, X., Wu, L., Lei, Y., Chen, H. 2015. Triacylglycerol composition profiling and comparison of high-oleic and normal peanut oils. Journal of the American Oil Chemists' Society, 92(2): 233-242.

Haro, R. J., Dardanelli, J. L., Martínez, M. J. 2020. Effect of soil temperature during seed filling period on oleic/linoleic ratio, tocopherols and sugar contents in peanut kernels. Grasas y Aceites, 71(3): 369.

Hu, X. H., Zhang, S. Z., Miao, H. R., Cui, F. G., Shen, Y., Yang, W. Q., Chen, J. 2018. High-density genetic map construction and identification of QTLs controlling oleic and linoleic acid in peanut using SLAF-seq and SSRs. Scientific reports, 8(1): 1-10.

Inuwa, H. M., Aina, V. O., Gabi, B., Aimola, I., Toyi, A. 2011. Comparative determination of antinutritional factors in groundnut oil and palm oil. Advance Journal of Food Science and Technology.

Lewis, M. A., Trabelsi, S., Nelson, S. O., Tollner, E. W. 2012. Analysis of stability and type independence of three density-independent calibration functions for microwave moisture sensing in shelled and unshelled peanuts. Transactions of the ASABE, 55(1): 189-198.

Liu, H., Hong, Y., Lu, Q., Li, H., Gu, J., Ren, L., Liang, X. 2019. Integrated analysis of comparative lipidomics and proteomics reveals the dynamic changes of lipid molecular species in high-oleic acid peanut seed. Journal of agricultural and food chemistry, 68(1): 426-438.

Liu, H., Li, H., Gu, J., Deng, L., Ren, L., Hong, Y., Liang, X. 2018. Identification of the candidate proteins related to oleic acid accumulation during peanut (Arachis hypogaea L.) seed development through comparative proteome analysis. International journal of molecular sciences, 19(4): 1235.

Nawade, B., Bosamia, T. C., Thankappan, R., Rathnakumar, A. L., Kumar, A., Dobaria, J. R., Mishra, G. P. 2016. Insights into the Indian peanut genotypes for ahFAD2 gene polymorphism regulating its oleic and linoleic acid fluxes. Frontiers in plant science, 7: 1271.

Nawade, B., Mishra, G. P., Radhakrishnan, T., Dodia, S. M., Ahmad, S., Kumar, A., Kundu, R. 2018. High oleic peanut breeding: Achievements, perspectives, and prospects. Trends in Food Science & Technology, 78: 107-119.

Nkuna, R. T., Wang, C. T., Wang, X. Z., Tang, Y. Y., Wang, Z. W., Zhang, J. C. 2021. Sodium azide induced high-oleic peanut (Arachis hypogaea L.) mutant of Virginia type. Genetic Resources and Crop Evolution, 68(5): 1759-1767.

Olmedo, R., Ribotta, P., Grosso, N. R. 2018. Oxidative stability, affective and discriminative sensory test of high oleic and regular peanut oil with addition of oregano essential oil. Journal of food science and technology, 55(12): 5133-5141.

Pawar, P. B., Khadilkar, J. P., Kulkarni, M. V., Melo, J. S. 2018. An approach to enhance nutritive quality of groundnut (Arachis hypogaea L.) seed oil through endo mycorrhizal fertigation. Biocatalysis and Agricultural Biotechnology, 14: 18-22.

Shin, E. C., Craft, B. D., Pegg, R. B., Phillips, R. D., Eitenmiller, R. R. 2010. Chemometric approach to fatty acid profiles in Runner-type peanut cultivars by principal component analysis (PCA). Food Chemistry, 119(3): 1262-1270.

Sodamade, A., Oyedepo, T., Bolaji, O. 2013. Fatty acids composition of three different vegetable oils (soybean oil, groundnut oil and coconut oil) by high-performance liquid chromatography. Extraction, 3(7): 126-178.

Tonnis, B., Wang, M. L., Li, X., Wang, J., Puppala, N., Tallury, S., Yu, J. 2020. Peanut FAD2 genotype and growing location interactions significantly affect the level of oleic acid in seeds. Journal of the American Oil Chemists' Society, 97(9): 1001-1010.

Wang, M. L., Khera, P., Pandey, M. K., Wang, H., Qiao, L., Feng, S., Guo, B. 2015. Genetic mapping of QTLs controlling fatty acids provided insights into the genetic control of fatty acid synthesis pathway in peanut (Arachis hypogaea L.). PLoS One, 10(4): e0119454.

Yusuf, K. A., Olaniyan, A. M., Atanda, E. O., Sulieman, I. A. 2014. Effects of heating temperature and seed condition on the yield and quality of mechanically expressed groundnut oil. Int J Technol Enhanc Emerg Eng Res, 2: 73-78.

Zhao, Z., Shi, A., Wang, Q., Zhou, J. 2019. High oleic acid peanut oil and extra virgin olive oil supplementation attenuate metabolic syndrome in rats by modulating the gut microbiota. Nutrients, 11(12): 3005.