AGPE THE ROYAL GONDWANA RESEARCH JOURNAL
OF HISTORY, SCIENCE, ECONOMIC, POLITICAL AND SOCIAL SCIENCE
ISSN (E): 2583-1348 | A Peer reviewed | Open Accsess & Indexed
Volume 04 | Issue 05 | May 2023 | *www.agpegondwanajournal.co.in* | Page No. 23-31

EVALUATION OF PROXIMATE AND MINERAL COMPOSITIONS OF FOUR DIFFERENT TYPES OF PEANUT SEED VARIETY IN MYANMAR

Cho M.[1*], Myat L.[2], Nang K. K. W[3], Kyi M.[4]

1. **Cho Mar**, Advanced Center for Agricultural Research and Education (ACARE), Department of Postharvest Technology, Yezin Agricultural University Naypyitaw, Myanmar
2. **Myat Lin**, Advanced Center for Agricultural Research and Education (ACARE), Department of Postharvest Technology, Yezin Agricultural University Naypyitaw, Myanmar
3. **Nang Kyu Kyu Win**, Department of Plant Pathology, Yezin Agricultural University Naypyitaw, Myanmar
4. **Kyi Moe**, Associate Professor in Department of Agronomy, Yezin Agricultural University, Naypyitaw, Myanmar

Abstract:

Peanut (groundnut) is the most important oil seed crop produced by Central Dry Zone in Myanmar. Peanut production and utilization have been important due to its high oil content and nutritive value. The main objective of this study was to evaluate the proximate and mineral compositions of four different types of peanut seed variety (Sinpadethar-11, Spain- 121, Pin Pyant 6 Month and Pin Pyant 4 Month) which were procured from Department of Agricultural Research (DAR), Ministry of Agriculture, Livestock and Irrigation. The proximate parameters were determined by standard method while mineral contents were analyzed by using Flame Atomic Absorption Spectrophotometry (FAAS) with dry ashing method. Peanut samples were examined for moisture, crude protein, crude fat, ash, crude fiber, total carbohydrate contents, thousand seeds weight, calcium and magnesium contents. The proximate composition results were ranged from the moisture (4.37- 5.06 %), ash (2.39-2.62 %), crude oil content (34.60 - 45.75 %), crude protein (22.23 - 26.50 %), crude fiber (6.77 - 8.89 %) and total carbohydrate contents (17.26 - 25.09 %) respectively. While the mineral compositions for peanut sample were (27.25 – 85.74 mg/100g) of calcium and (124.19 - 299.56 mg/100g) of magnesium respectively.

Key Words- Peanut seed, four varieties, proximate, minerals, dry ashing method, AAS

CORRESPONDING AUTHOR:	RESEARCH ARTICLE
Dr. Myat Lin Professor and Head, Department of Postharvest Technology, (ACARE), Yezin Agricultural University (YAU) Email: drmyatlinn@yau.edu.mm	

1. Introduction

Peanut (*Arachis hypogaea* L.) is a plant of pea family and it is an important oilseed and food crop. It is an annual legume. As one of the major oilseed crops in the world, peanut is planted in more than 100 countries, but the sensory quality, nutritional quality, and processing characteristics of peanuts planted in different regions and different varieties are significantly different. Numerous studies have shown that peanuts have many health benefits. Peanut seeds are rich in Vitamin E, niacin, folacin, riboflavin, thiamin, calcium, phosphorus, magnesium, zinc, iron, and potassium. Peanut has a good source of magnesium and calcium in seeds which help to maintain normal blood pressure. Peanuts are high in protein, heart-healthy oils, fiber and many important nutrients (Muhsen, Clarke & Kagan, 2003). Peanut may promote the heart health. Peanuts are an excellent source of vitamin E which may also reduce heart disease risk (Savage and Keenan, 1994). However, peanut can cause allergic reactions. Allergic reactions are due to allergenic seed storage proteins that elicit specific immunoglobulin E (IgE) antibodies. All food allergies have the potential to induce anaphylaxis, but some foods are more likely than others to cause potentially life-threatening reactions (Ros, 2010).

There is a wide variation in types and strains cultivated in particular localities. In Myanmar, the two main types grown commercially are distinct in appearance. One is the upright with an erect central stem and vertical branches. The second one is the recumbent with numerous creeping laterals. The cultivation of peanut is still taking major role in oil seed crops in Myanmar (Bir Mandal, 2008). Oil seed crops occupy a total area of 3.2 million hectares out of which 24% is under peanut (0.76 mil. ha) with a production of 1.1 m tons. Half of the peanut areas (0.34mil. ha) is growing during the raining season (Favre & Myint 2009). Over 79% of the total oil seed crops production comes from Central Myanmar: Sagaing, Magway and Mandalay Region (Lat, Zaw. Ko, 2019).

The oil content of peanut differs in quality, the relative proportion of fatty acids, geographical location, seasons and growing conditions (Brown et al., 1975; Holaday and Pearson, 1974; Young et al., 1974). The peanut seed has from 36 to 54% oil (Knauft and Ozias-Akins, 1995). Peanut seeds contain 20-50% protein and 10-20% carbohydrate depending on the variety. They are also dense in a variety of other nutrients and provide dietary fiber, vitamins (e.g., folic acid, niacin, tocopherols, vitamin B6) and minerals (e.g., calcium, magnesium, potassium) (Blomhoff et al., 2006). The level of calcium was within the ranged from 44 to 134 mg/100 g in peanut varieties (Asibuo et al., 2008). Calcium (Ca) is vital for healthy teeth, bone, aids muscle growth and prevent muscle cramps (Chowdhury et al., 2015). Peanuts are rich in proteins which are easily digestible and it is a higher biological value. The higher the crude fiber content, the better the function of body to maintain a normal intestinal tract because diet low in crude fiber may cause constipation and colon diseases. The crude protein content in the peanut varieties ranged from 19.7 - 31.3 % (Kalejaiye, 2010). Due to rich in protein contents, it is an important item such as peanut flour, peanut butter, salted and roasted nuts in several confectionery products. The main function of carbohydrate is the energy supply to the body.

This study was carried out to find out the proximate and mineral compositions of four different types of peanut seed variety. The proximate and minerals compositions of peanut seeds are very important for suitable purpose of peanut uses and human health. Pre-determined nutritional values for different types of peanut variety before extraction is very important in developed countries. However, studied on the proximate and mineral compositions of peanut varieties in Myanmar was rarely determined and have not been conducted the benefit of peanut for human health.

2. Objective

The main objective of this study was to evaluate the proximate and minerals composition of four different types of peanut seed variety to inform health benefit to human, oil extraction industries and confectionary manufacturers to choose the right varieties for intended purposes.

3. Materials and Methods

3.1 Materials

Samples of four different types peanut seed variety were procured from Department of Agricultural Research (DAR), Ministry of Agriculture, Livestock and Irrigation. This experiment was conducted at the laboratory of Department of Postharvest Technology, Advanced Center for Agricultural Research and Education (ACARE), Yezin Agricultural University, Nay Pyi Taw and Department of Research, Myanma Pharmaceutical Industries, Ministry of Industry, Yangon from December 2021 to March 2022.

3.2 Analytical Methods

3.2.1 Determination of moisture

The moisture content of sample was determined using an oven drying method and the results expressed as percentage moisture content (AOAC, 2005). Moisture content of the crushed powder of peanut sample is the loss in mass of the sample on heating at 105˚C under specific conditions to obtain constant weight with three replications. Weigh 10 g of the peanut powder in a previously dried and weighed dish and then opened the lid and heat in an oven at 105˚C for 1 hour. Remove the dish from the oven and close the lid. Cool in desiccators containing equivalent desiccant and weigh. Then heat in the oven for a further period of 1 hour, cool and weigh. Repeat this process until change in weight between two successive observations does not exceed 1mg.

3.2.2 Determination of crude protein

The protein content of the four different types of peanut seed variety were determined from the total nitrogen determined by Kjeldhal method (AOAC, 2005) with 3 steps; digestion, distillation and auto-titration. Protein estimation of sample was carried out by using DKL heating digester and UDK automatic distillation and titration system (Velp Scientifica, F30100210, Italy).

3.2.3 Determination of crude fat

The crude fat content was conveniently determined by extracting the dried and ground material of peanut seed with petroleum ether in solvent auto extraction fat analyzer (Velp, Scientifica SER 158 solvent auto extractor) (AOAC, 2003).

3.2.4 Determination of total ash

Ash refers to the inorganic residue after total incineration of organic matter. Ash content was obtained by charring the five grams of samples on the hot plate and then moved in a muffle furnace at 600°C until a light-grey ash was produced. After ignition, the crucible was cooled in muffle furnace for 2 h to cool down to 300°C. And then, the crucible was placed in a desiccator for 30 min. Ash content was calculated according to AOAC, 2007.

3.2.5 Determination of crude fiber

Crude fiber content was measured according to the method described by AOAC (2005) using Velp Scientifica Ankom 200 fiber analyzer.

3.2.6 Determination of carbohydrate

The content of carbohydrates was estimated according to Raghuramulu et al., (2003)

Carbohydrate content (%) = 100 − [Percent of Moisture + Proteins+ Crude fat+ Ash + Crude fiber]

3.2.7 Mineral Analysis

The dry ashing method was used for minerals analysis. Peanut samples (0.5 g) were weighed into a crucible, charred on hot plate and then ashed in a muffle furnace at 600 ˚C for 4 h. After ashing was complete, to prepare the sample solution, add 1-2 ml of deionized water and 1 ml of conc: HNO_3 (65% Ultra-Pure), keep the solution at room temperature for 10 to 15 minutes and then start heating it on hot plate at low heat for dissolution of all metals. Likewise, 2-3 times this step was respected only with deionized water and solution was filtered through whatman No. 41 (pore size 0.25 micro meter) to volumetric flask (50 ml) and made up to the volume with deionized water. The sample is now ready for determination of macro elements of Magnesium (Mg) and Calcium (Ca) with standards of hollow cathode lamps by using Frame Atomic Absorption Spectrophotometer. (Spectrum, SP-AA 4000 Spectrophotometer, Germany)

4. Statistical Analysis

The results were statistically analyzed by using statistix software (8^{th} version). All treatment were carried out three replications with Completely Randomized Design (CRD). Mean comparison was carried out Least Significant Difference (LSD) at 5% level.

5. Results and Discussion

The proximate composition of the four different types of peanut variety is shown in Table 1. All the parameters generally showed significant difference ($p < 0.05$) of the different types of peanut seed samples. The lowest value of moisture content was 4.3 % for Pin Pyant 6 Month and

Pin Pyant 4 Month while the highest value was 5.06 % for the Spain-121. These values are lower than that (7.48 %) of raw peanut seed and this was caused by the decrease of moisture content during sun drying which is an important step of samples to adjust the moisture content before analysis of proximate and mineral compositions (Ayoola & Adeyeye, 2010). Crude protein content is the major nutrient components found in different varieties of peanut. The peanut protein is plant based, most of the fat is unsaturated which makes peanut the best form of human nutrition (Bolanle et al., 2020). According to (Watt and Merrill, 1963), plant foods that provide more than 12% of its calorific value from protein are considered good source of potential source of protein. Crude protein in the peanut varieties studied ranged from 22.23 - 26.50%. This range compares favorably with the 20-30% reported by Metcalfe & Elkins (1980) and Atasie, Akinhanmi & Ojiodu (2009). The highest amount of protein was obtained from erect type of Sinpadethar-11 (26.50%). The lowest protein content was found in recumbent type of Pin Pyant 4 Month (22.23%). In this view to protein content of 21-30 %, the studied peanut samples could be considered as a valuable source of protein in improving the nutritious sample for humans. The results also demonstrate that peanut is a valuable source of protein for improving the nutrition of human health and farm animals (Asibuo et al., 2008).

Table 1. Proximate compositions of the four different types of peanut seed variety

Treatment (Variety)	Moisture (%)	Protein (%)	Crude oil (%)	Ash (%)	Crude Fiber (%)	Carbohydrate (%)
Sinpadethar-11	4.88±0.05 b	26.50±0.34 a	34.60±0.14 d	2.39±0.03 b	6.77±0.13 d	25.09±0.04 a
Spain-121	5.06 ±0.03 a	26.41±0.29 a	35.61±0.36 b	2.45±0.11 b	8.89±0.30 a	21.38±0.92 b
Pin Pyant (6 Month)	4.39±0.03 c	22.57±0.12 b	45.75±0.31 a	2.40±0.02 c	7.70±0.26 c	17.26±0.31 c
Pin Pyant (4 Month)	4.37±0.16 c	22.23±0.08 b	40.29±0.19 b	2.62±0.07 a	8.23±0.18 b	22.24±0.10 b
LSD ($_{0.05}$)	0.157	0.441	0.449	0.126	0.427	0.919
Pr>F	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
CV%	1.78	0.96	0.61	2.72	2.88	2.27

In a column, means followed by same letter are not significantly different at (α=0.05).

Crude oil content observed in this study for four different types of peanut variety were ranged from 34.60 to 45.75%. This finding was in line with the report of Atasie, Akinhanmi and Ojiodu (2009) who revealed oil content was 47%. The mean oil content of recumbent types was obviously higher than that of erect types. The lowest amount of crude oil content was obtained from erect type of Sinpadethar-11 (34.60%) and the highest crude oil content was found in recumbent type of Pin Pyant 6 Month (45.75%). Pin Pyant 6 Month had the highest amount of crude oil content among four different types of peanut variety.

Ash content in Table 1 of in four different types of peanut variety were variable and ranged from 2.39% to 2.62%. The variety, Pin Pyant 4 Month gave the highest amount of ash (2.62%) and the lowest amount of ash content (2.39%) was obtained from Sinpadethar-11. The ash content (2.0 - 7.4%) of the peanut varieties is to some extent indicative of mineral content (Jossyln, 1973). The present investigation was expected that Pin Pyant 6 Month and Pin Pyant 4 Month with highest ash content would have the highest mineral content. The rise in fibre content could be due to the browning reactions to produce some products which may be analyzed as lignin (Udo et al., 2021). Crude fiber content of peanut variety of Spain-121 increased significantly to the highest level of 8.89% followed by Pin Pyant 4 Month (8.23%) and decreased to the lowest level of 6.77% was recorded in Sinpadethar-11.

The highest amount of carbohydrate content was found in Sinpadethar-11 (25.09%) followed by Pin Pyant 4 Month (22.24%) and Spain-121 (21.38%) respectively. The lowest amount of carbohydrate was obtained from Pin Pyant 6 month (17.26%). These present investigations of the carbohydrate content might be influenced by agronomics practices, environmental factors as well as variation among the varieties. (Gomaa & Nassaar, 2019).

Thousand seed weight of four different types of peanut seed variety is presented in Table 2. It was found that thousand seed weight depend on their size, shape and weight. Seed weights were determined after sun drying to adjust the 5% moisture contents. The highest thousand seed weight was found in Sinpadethar-11 (46.16 g) and then followed by Pin Pyant 6 Month (34.36 g) and Spain-121 (31.15 g). Statistically similar results were shown by Spain-121 of 31.15 g and Pin Pyant 4 Month of 31.34 g respectively.

Table 2. Thousand seeds weight and mineral compositions of the four different types of peanut variety

Treatment (Variety)	Thousand seeds weight (g)	Calcium (mg/100g)	Magnesium (mg/ 100g)
Sinpadethar-11	46.16±0.21 a	69.99±0.30 c	242.88±0.06 b
Spain-121	31.15±0.17 c	72.71±0.22 b	124.19±0.13 d
Pin Pyant (6 Month)	34.36±0.14 b	25.25±0.18 d	299.56±1.26 a
Pin Pyant (4 Month)	31.34±0.31 c	85.74±0.74 a	200.66±0.03 c
LSD ($_{0.05}$)	0.405	0.943	2.694
Pr>F	<0.0001	<0.0001	<0.0001
CV%	0.60	0.78	0.66

In a column, means followed by same letter are not significantly different at (α=0.05).

In case of calcium content of four different types of peanut variety were ranged from 27.25 mg/100g to 85.74 mg/100g in table 2. The highest amount of calcium (Ca) content was significantly observed in Pin Pyant 4 Month (85.74 mg/100g) and this could be attributed due to calcium fertilizer and planting period, followed by Spain-121 (72.71 mg/100g) and Pin Pyant 6 Month (25.25 mg/100g). The maximum content of magnesium (Mg) was observed in Pin Pyant 6 Month (299.56 mg/100g), followed by Sinpadethar-11 (242.88 mg/100g), Pin Pyant 4 Month (200.66 mg/100g) and Spain-121 (124.19 mg/100g) respectively. Magnesium has also been reported to be

involved in maintaining the electrical potential in nerves and activation of some enzyme. Asibuo et al., (2008) found that the ranges of 92-200 mg/100 g of calcium and 10-343 mg /100 g of magnesium. The present investigations of calcium and magnesium were supported by reported value of Asibuo et al., (2008) and Atasie et al., (2009).

This research revealed that peanut was an excellent and valuable source of nutrition, supplementing vital nutrients to the human health such as carbohydrates, proteins, fats, calcium and magnesium. Peanut is an important source of oil seed crop that has been used as a potential source of edible oil. Peanut is a source of protein and fat for the body that reduce the risk of heart-related diseases. Peanut is energy dense foods rich in bioactive compounds and many nutrients. This research was concluded that the presence of maximum oil content was found in Pin Pyant 6 Month among the four different types of peanut variety. The suitability of the investigated peanut variety (Pin Pyant 6 Month) with maximum oil content for extraction of oil industries. Sinpadethar-11 was found the maximum protein content that might be suitable for confectionary and roasted peanut which had lowest crude oil content that can prevent the formation of free fatty acid and lipid oxidization. The low ash content is an indicative of low level of inorganic impurities and as a good source of mineral element. This research stated to prevent against the mineral's deficiencies because the nutritive value of peanut seeds contained increased amount of calcium in Pin Pyant 4 Month and magnesium in Pin Pyant 6 Month. The proximate and mineral compositions of different types of peanut seed variety have been analyzed to inform the benefit of nutritional values for human health.

6. Conclusion

This research may be concluded that the presence of maximum oil content was found in Pin Pyant 6 Month among the four different types of peanut seed variety. The suitability of the investigated peanut variety (Pin Pyant 6 Month) with maximum oil content for extraction of oil industries. Sinpadethar-11 was found the maximum protein content that might be suitable for confectionary, peanut butter making and roasted peanut which had lowest crude oil content that can prevent the formation of free fatty acid and lipid oxidization. The low ash content is an indicative of low level of inorganic impurities and as a good source of mineral element. This research revealed to prevent against the mineral's deficiencies because the nutritive value of peanut seeds contained highest amount of calcium in Pin Pyant 4 Month and magnesium in Pin Pyant 6 Month. The proximate and mineral compositions of different types of peanut seed variety were analyzed to inform the benefit of nutritional values for human.

7. Acknowledgement

We are grateful to India-Myanmar Friendship Project, Dr. Myat Lin (Professor and Head, Department of Postharvest Technology, (ACARE), Yezin Agricultural University, Dr. Nang Kyu Kyu Win (Professor, Department of Plant Pathology, Yezin Agricultural University) and Dr. Kyi Moe (Associate Professor, Department of Agronomy, Yezin Agricultural University) for the valuable knowledge support until the finishing of this research.

8. References

1. A Bolanle, M. K., Bello, M. N., Emmanuel, E., Abdullateef, A., & Saleh, J, 2020. Nutrients Composition and Aflatoxin Contents of some locally cultivated Groundnuts in Sokoto State, Nigeria.
2. Al-Muhsen, S., Clarke, A. E., & Kagan, R. S. (2003). Peanut allergy: an overview. Cmaj, 168(10), 1279-1285.
3. AOAC 2003, Official methods of analysis of the association of official's analytical chemists, 17th edition. Association of official analytical chemists, Arlington, Virginia.
4. AOAC 2005, Official Methods of Analysis. Association of Official Analytical Chemists, 13th edition, Washington, D.C.
5. Aremu, M.O., O. Olaofe and E.T. Akintayo, 2006. Chemical Composition and Physicochemical Characteristics of Two Varieties of Bambara Groundnut (Vigna subterrenea) Flours. Journal of Applied Sciences, 6: 1900-1903
6. Asibuo, J. Y., Akromah, R., Safo-Kantanka, O., Adu-Dapaah, H. K., Ohemeng-Dapaah, S., & Agyeman, A. (2008). Chemical composition of groundnut, Arachis hypogaea (L) landraces. African Journal of Biotechnology, 7(13).
7. Atasie, V. N., Akinhanmi, T. F., & Ojiodu, C. C. (2009). Proximate analysis and physico-chemical properties of groundnut (Arachis hypogaea L.). *Pakistan journal of Nutrition*, *8*(2), 194-197.PXA 111.2009
8. Ayoola PP, Adeyeye A, 2010. Effect of heating on the chemical composition and the physicochemical properties of Arachis hypogea (groundnut) seed flour and oil. Pakistan Journal of Nutrition 9: 751-754.
9. Belete, A., & Bayissa, L. D. (2020). Proximate and Mineral Compositions of Raw and Roasted Groundnut (Arachis Hypogaea L.) Obtained from East Hararghe Zone, Ethiopia. *Journal of Science and Sustainable Development*, *8*(1), 26-38.
10. Belton, B., & Mather, D. (2018). Pulse and Oilseed Traders in Central Myanmar: Value chain structure and conduct.
11. Bir C. Mandal, 2008. Manual On Major Annual Oilseed Crops of Myanmar. (Bir Mandal, 2008) (Book)
12. Blomhoff, R.; Carlsen, M.H.; Frost Andersen, L.; Jacobs, D.R. Jr. Health benefits of nuts, potential role of antioxidants. Br. J. Nutr. 2006, 96, S52-S60.
13. Brown DF, Cater CM, Mattil KF, Darroch JG (1975). Effect of variety, growing location and their interaction on the fatty acid composition of peanuts. J. Food Sci. 40: 1055-1060
14. Chowdhury, F. N., Hossain, D., Hosen, M., & Rahman, S. (2015). Comparative study on chemical composition of five varieties of groundnut (Arachis hypogaea). World J. of Agricultural Science, 11(5), 247-254.
15. FAO/WHO, 2007. Protein requirement in human nutrition. FAO Ed, 265 p.
16. Favre, R., & Myint, K. (2009). An analysis of the Myanmar edible oil crops sub-sector. Rural Infrastructure and Agro-Industries Division, Food and Agriculture Organization of the United Nations
17. George D. Encyclopedia of foods and their healing power: review and herald publishing Maryland USA.2004;1:4-12.
18. Gomaa, R. A., & Nassaar, S. M. A. (2019). Evaluation of some new peanut oil varieties. Minia J. Agric. Res. & Develop, 38(4), 671-286.

19. Holaday PE, Pearson JL (1974). Effects of genotype and production area on the fatty acid composition, total oil and total protein in peanuts. J. Food Sci. 39: 1206-1209.
20. Knanft, D.A. and Ozias-Akins, P., 1995. Recent methodologies for germplasm enhancement and breeding. In: eds. H.E. Pattee and H.T. Stalker, Advances in Peanut Science, Am. Peanut Res. and Educ. Soc., Inc., Stillwater, OK, pp. 54-94
21. Lat, Zaw. Ko. (2019). A Study of Public Awareness On Edible Oil Consumption In Myanmar (Case Study: Insein Township and Mayangon Township) (Doctoral dissertation, MERAL Portal).
22. Methods in food analysis. Academic Press. Inc. New York.
23. Miret, S., R.J. Simpson and A.T. McKie, 2003. Physiology and Molecular Biology of Dietary Iron absorption, Annual Review of Nutrition, 23: 283-301.
24. Musa, A. K., Kalejaiye, D. M., Ismaila, L. E., & Oyerinde, A. A. (2010). Proximate composition of selected groundnut varieties and their susceptibility to Trogoderma granarium Everts attack. *J. Stored Prod. Postharvest Res*, *1*, 13-17.
25. Ros, E. (2010). Health benefits of nut consumption. *Nutrients*, *2*(7), 652-682.
26. Savage, G. P., & Keenan, J. I. (1994). The composition and nutritive value of groundnut kernels. *The groundnut crop: A scientific basis for improvement*, 173-213.
27. Udo, N. N., Effiong, O. O., George, U. E., & Okon, E. J. (2021). Effects of processing on the mineral content and proximate composition of Arachis hypogeae (Groundnut) seeds. *World Journal of Advanced Research and Reviews*, *12*(1), 387-395.
28. Watt, B. K., & Merrill, A. L. (1963). Composition of Foods. Agricultural Handbook No. 8. *US Department of Agriculture, Washington, DC, 190*.
29. Young CT, Worthington RE, Hammons RO, Matlock RS, Waller GR, Morrison RD (1974). Fatty acid composition of Spanish peanut oils as influenced by planting location, soil moisture conditions, variety, and season. J. Am. Oil Chem. Soc. 51: 312-315

■ ■ ■