Comparison of Physicochemical Properties of Peanut Oil from Different Oil Factories in Shwebo

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ABSTRACT

In this project paper, three samples of peanut oil were collected from different locations of oil factories in Shwebo Township. The physicochemical properties such as rancidity, specific gravity, %free fatty acid, iodine value, peroxide value, and saponification value of commercial peanut oils were investigated. Moreover, the concentrations of saturated and unsaturated fatty acids in peanut oil samples were also analyzed by Gas Liquid Chromatography (GLC).

Keywords : peanut oil, rancidity, specific gravity, %FFA, IV value, peroxide value, saponification value , gas liquid chromatography (GLC).

1. INTRODUCTION

VEGETABLE oils in particular are natural products of plant origin consisting of ester mixtures derived from glycerol with chains of fatty acid contain about 14 to 20 carbon atoms with different degrees of unsaturation. Vegetable oils play important functional and sensory roles in food products, and they act as carriers of fat-soluble vitamins (A, D, E and K). They also provide energy and essential linoleic and linolenic acids, responsible for growth. One important parameter of different vegetable oils is the amount of unsaturation of the constituent fatty acids. Most native oils and fats have limited applications in their unmodified forms, imposed by their triacylglycerol (TAG) and fatty acid (FA) compositions. It is widely known that the physical and chemical properties of oils are a strong function of the TAG and FA composition. By changing the natural physical and chemical characteristics of a fat or oil, it offers greater functionality for a large number of product formulations. Physical-chemical properties of triglyceride and its applications depend upon fatty acid constituents in molecule. However, the differences are due primarily to chain length degree and position of unsaturation. (Ong A.S. H)

Vegetable and edible oils had made an important contribution to the diet of people in many countries, serving as a good source of protein, lipid and fatty acid for human nutrition including the repair of worn out tissues, new cells formation as well as a useful source of energy. (Atasie, V. N)

Edible oil is an essential nutrient and an important source of energy providing 9 kcal / g. For oil to be utilized as a source of energy it must be well digested and absorbed into the body. Oils in the diet are available to the body as fatty acids, which are excellent sources of dietary calorie in-take; the major sources of edible oil are groundnut and oil palm. These oils are used mainly as cooking oils and for the production of soap, margarine, and cosmetics .Oil quality and its stability are therefore very important for the consumers and in applications to industries. (Ong A.S. H)

Peanut oil is high quality and can withstand higher temperature without burning or breaking down. It has neutral flavor and odour. It does not absorb odours from other foods. Peanut oils are classed as oleic-linoleic acid oils. They contain a relatively high proportion of unsaturated fatty acids such as the monounsaturated oleic acid and the polyunsaturated linoleic acid. They are characterized by a high ratio of polyunsaturated fatty acids to saturated fatty acids. (Overhults, D.G)

In this project paper, the physicochemical properties of peanut oil from different oil factories in Shwebo were examined. Moreover, the amounts of saturated and unsaturated fatty acids were also determined by gas chromatography (GC). In this regard, this study will consider the edibility of these oils based on the aforementioned properties.

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2 EXPERIMENTAL

2.1 Sample Collection

In this research paper, the physicochemical properties of peanut oil from different oil factories in Shwebo were examined. Sample 1,2 and 3 of peanut oils were centrifuged for remove the precipitations and stored in glass bottle for analyzed the amounts of saturated and unsaturated fatty acids were also determined by Gas Liquid Chromatograpy (GLC). All chemicals were used of analytical reagent grade.

2.2 Determination of Specific gravity

Cleaned,dried pycnometer was weighed. It was filled with water maintained at 30℃ and weight again. The bottle was emptied, dried and filled with oil and weighed. The value was calculated using following equation.

$$\text{specific gravity} = \frac{\text{weight of oil}}{\text{weight of water at } 30^{o}\text{C}}$$

2.3 Determination of Racidity

Peanut oil (1.0) g was weight in conical flask and 50ml of neutral ethanol was added. The mixture was stirred with magnetic stirrer. And then 2 drops of phenolphthalein indicator was added and the solution titrated against 0.25N NaOH with vigorous shaking until permanent light pink colour was obtained. The value was calculated using following equation.

$$\text{Percent acid value} = \frac{100 \times 2.82 \times v}{W \times 1000 \times 4}$$

Where W = weight of oil, v = tire value of 0.25 N NaOH,

2.82 = equivalent weight of oleic acid

2.4 Determination of Percent Free Fatty Acid

10g of oil was boiled with 50ml ethanol, allowed to cool and 2 drops of phenolphthalein indicator was added. It was titrated against 0.1N NaOH until pink colour was obtained. The value was calculated using following equation.

$$\text{Percent free fatty acid} = \frac{\text{true value} \times 2.82}{\text{Weight of sample}}$$

2.5 Determination of Peroxide value

Oil sample (5.0 g) was accurately weighed into a conical flask, and dissolved in solvent mixture containing 12 ml chloroform and 18 ml glacial acetic acid. To the solution 0.5 ml of a saturated aqueous potassium iodide solution was added. The flask was stoppered and allowed to stand for 1 min. 30 ml of water was added and the solution was titrated with 0.1 M sodium thiosulphate solution until the yellow colour had almost gone. About 0.5 ml of starch solution was introduced and titration continued with the reagent added slowly until the blue black colour disappeared. During the titration, the flask was continuously and vigorously shaken to transfer the liberated Iodine from the chloroform layer to the aqueous layer. A blank titration was also performed, and the peroxide value was obtained from the formula:

$$\text{Peroxide value} = \frac{F \times (A - B) \times 10}{\text{Weight of oil (g)}}$$

where, F = factor of 0.1N $Na_2S_2O_3$, A = sample titre value, B = blank titre value

2.6 Determination of Iodine Value

0.3 g of peanut oil was weighed accurately. 10ml of CCl_4 and 25 ml of Wij's solution were added successively and the flask was vortexes and allowed to stand in a dark cupboard for 1 hour. 15ml of 10% potassium iodide and 100ml of distilled water were added followed by 1ml of starch solution. It was titrated against 0.1N $Na_2S_2O_3$ until the blue colour disappeared indicating an end point. Blank solution was titrated without the oil sample. The value was calculated using following equation.

$$\text{Iodine value} = \frac{(b - a) \times N \times 1.269 \times 100}{W}$$

Where b = blank titre value , a = sample titre value ,W = weight of sample

N = normality of thiosulphate,

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2.7 Determination of Saponification Value

0.5g of the peanut oil was weighed in a quick-fit reflux flask and 25ml alcoholic KOH was added. It was refluxed for 30 minutes, so that it gets simmer. The flask was cooled and 1 ml of phenolphthalein indicator was added and titrated against 0.5N HCL. The value was calculated using following equation.

$$\text{Sponification value} = \frac{56.1 \times (b - a) \times N}{W}$$

Where W = weight of sample = 0.5g, b = blank titre value, a = sample titre value,

N= Normality of HCL.

2.8 Analysis of Saturated and Unsaturated Fatty Acid Concentrations by Gas Chromatography

The amounts of saturated and unsaturated fatty acids of different peanut oil were determined by Gas Liquid Chromatography (GLC) method from Myanmar Inspection & Testing Services Ltd. in Mandalay. These results were shown in table (2) table, (3) table (4) and then figure (3), (4), (5) and (6).

3. RESULTS AND DISCUSSION

3.1 Physicochemical Properties of Peanut Oils

In this project paper, the physicochemical properties of peanut oil from different oil factories in Shwebo were examined. The physicochemical properties of each oil sample were analyzed by using standard analytical method. And then these results were shown in table (1) and figure (1) and (2).

Table (1) Results of the Physicochemical Properties of the Three Peanut Oil Samples

No.	Tests	Sample -1	Sample -2	Sample-3
1.	Specific gravity	0.9626	0.9533	0.9611
2.	% free fatty acid	3.0	6.5	2.4
3.	Peroxide value (mLEq/ kg)	6.8	5.5	4
4.	Iodine value (g/100g)	91	93	97
5.	Saponification value (mgKOH/g)	196	202	192
6.	Racidity	incipient	incipient	incipient

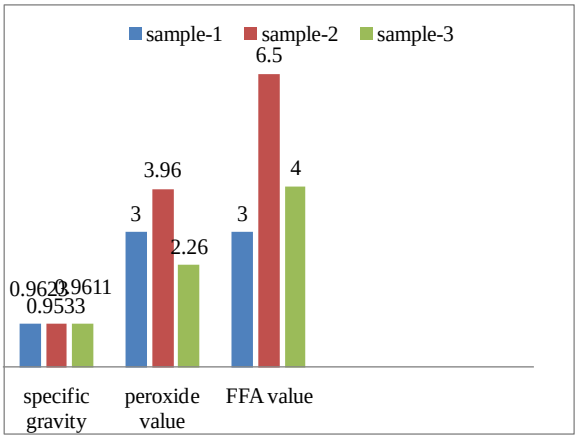

Fig 1 Physicochemical properties of sample-1, 2 and 3

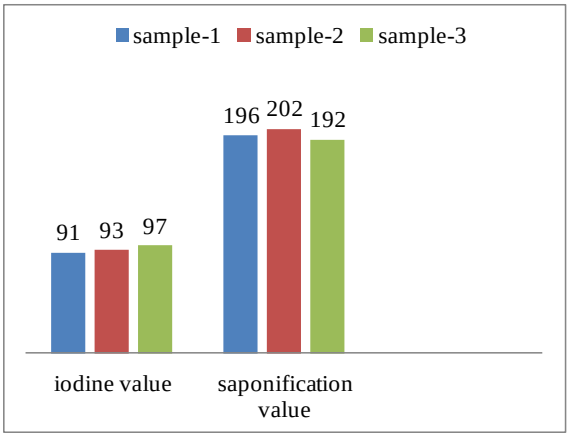

Fig 2 Chemical properties of sample-1, 2 and 3

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From the results of table (1), figure (1) and (2), there was no significant difference between the specific gravity of the different oil samples. The range is from 0.9533 to 0.9623. The high percentage free fatty acid value of sample-2 is 6.5 but sample-1 has the lowest percentage free fatty acid value is 3. High quality oils are low in free fatty acids. So, sample-3 is more suitable for consumption and storage. The higher iodine value of sample-3 is 97 than the other samples. The highest iodine value indicates that the fatty acid presence is unsaturated especially oleic acid. The iodine value is an indicator of the degree of unsaturation, a great value of IV indicating oil prone to oxidation. The unsaturated character affects the stability of oils, and, as a result, leads to the appearance of degradation effects during storage. From the studied oils, the peanut oil is characterized by the greatest IV. The acid value is a measure of the free fatty acids content of the oil. The saponification value of oil samples are obtained from 192 to 202. The saponification value suggests that the mean molecular weight of fatty acids is lower or that the number of ester bonds is less. This might imply that the fat molecules did not interact with each other. The low iodine values may have contributed to its greater oxidative storage stability. The oxidative and chemical changes in oils during storage are characterized by an increase in free fatty acid contents and a decrease in the total unsaturation of oil. Saponification value is a measure of oxidation during storage, and also indicates deterioration of the oils.

3.2 Analysis of Saturated and Unsaturated Fatty Acid Concentrations by Gas Liquid Chromatography

The amounts of saturated and unsaturated fatty acids of different peanut oil were determined by gas liquid chromatography (GLC) method from Myanmar Inspection & Testing Services Ltd. in Mandalay. These results were shown in table (2), table (3), and table (4) and then figure (3), (4), (5) and (6).

Table (2) Results of the Fatty Acid Concentration in Peanut Oil Sample-1

Peak	Component name	Ret. Time (Min)	Result of Norm. Area (%)	Condex Standard (Peanut Oil)
3	C 16:1 (Palmitoleic)	11.269	0.12	ND – 0.2
4	C 16:0 (Palmitic)	11.476	20.21	8.0 – 14.0
5	C 18:1 (Oleic)	13.295	62.05	35.0 - 69
6	C 18:0 (Stearic)	13.612	6.75	1.0 – 4.5
8	C 20:0 (Arachidic)	16.011	2.75	1.0 – 2.0
9	C 22:0 (Beheric)	19.045	6.08	1.5 – 4.5
10	C 24:0 (Lignoceric)	23.787	2.04	0.5 – 2.5

According to table (2) and figure (4), the most prominent of fatty acids in sample-1 were palmitic acid (16:1) (20.21%) and oleic acid (18:1) (62.05%).

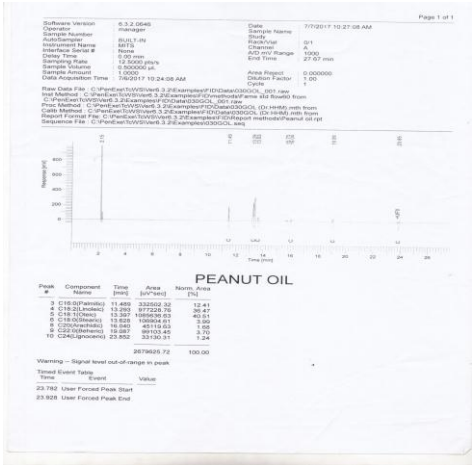

Fig 3 Gas Chromatogram of standard fatty acid

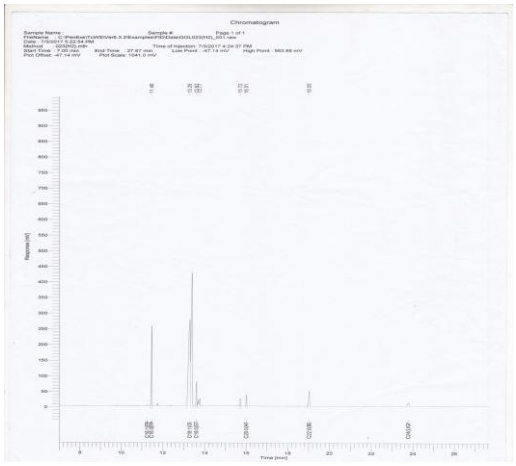

Fig 4 Gas Chromatogram of sample-1

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Table (3) Results of the Fatty Acid Concentration in Peanut Oil Sample-2

Peak	Component name	Ret. Time (Min)	Result of Norm. Area (%)	Condex Standard (Peanut Oil)
3	C 16:0 (Palmitic)	11.489	12.41	8.0 - 14.0
4	C 18:2 (Linoleic)	13.290	36.47	12.0 - 43
5	C 18:1 (Oleic)	13.397	40.51	35.0 - 69
6	C 18:0 (Stearic)	13.628	3.99	1.0 – 4.5
8	C 20:0 (Arachidic)	16.040	1.68	1.0 – 2.0
9	C 22:0 (Beheric)	19.087	3.70	1.5 – 4.5
10	C 24:0 (Lignoceric)	23.852	1.24	0.5 – 2.5

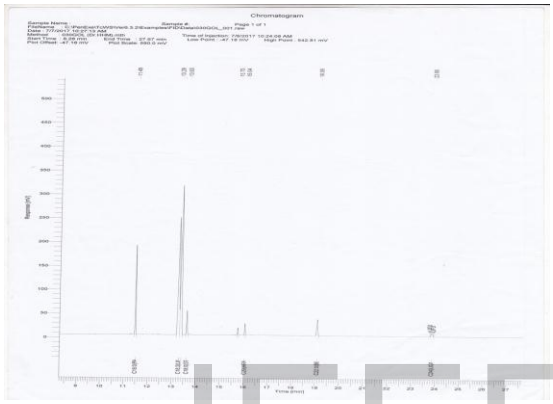

Fig 5 Gas Chromatogram of sample-2

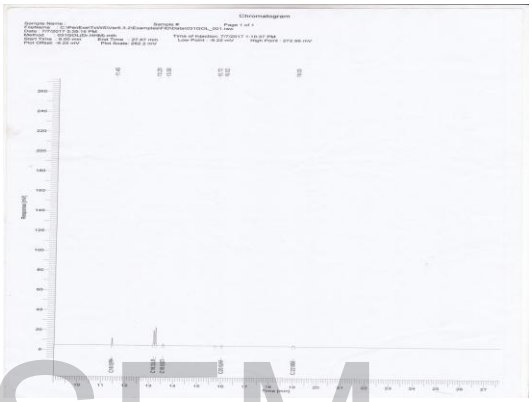

Fig 6 Gas Chromatogram of sample-3

From table (3) and figure (5), sample-2 contains higher unsaturated fatty acids content of linoleic acid (18:2) (36.47%) and oleic acid (18:1) (40.51%). The palmitic acid (16:0) content (12.41%) contain in sample-2.

Table (4) Results of the Fatty Acid Concentration in Peanut Oil Sample-3

Peak	Component name	Ret. Time (Min)	Result of Norm. Area (%)	Condex Standard (Peanut Oil)
4	C 16:0 (Palmitic)	11.452	12.33	8.0 - 14.0
5	C 18:2 (Linoleic)	13.196	35.96	12.0 - 43
6	C 18:1 (Oleic)	13.272	42.51	35.0 - 69
7	C 18:0 (Stearic)	13.578	4.01	1.0 – 4.5
9	C 20:0 (Arachidic)	16.016	1.62	1.0 – 2.0
10	C 22:0 (Beheric)	19.029	3.58	1.5 – 4.5

Table (4) and figure (5) show unsaturated fatty acid of linoleic acid (18:2) (35.96%) and oleic acid (18:1) (42.52%) present in sample-3. And also contains saturated fatty acid of palmitic acid (16:0) (12.33%) in sample-3.

All samples contain saturated fatty acid (palmitic acid), monounsaturated fatty acid (oleic acid) and polyunsaturated fatty acids (linoleic acid) were found in all samples-1, 2 and 3. A high dietary intake of saturated fatty acid is a risk factor for development of obesity, cardiovascular disease. The high content of monounsaturated fatty acids especially oleic acid is associated with a low incidence of coronary heart disease because it decreases total cholesterol (10%) and low-density lipoprotein cholesterol. The dietary intake of certain polyunsaturated fatty acids, in particular conjugated linoleic and fat-soluble antioxidants has been linked to potential health benefits.

The fatty acid compositions of three oil sample-1, 2 and3 were determined by using Gas Liquid Chromatography (GLC). According to the results, all samples contain saturated fatty acid (palmitic acid), monounsaturated fatty acid (oleic acid) and polyunsaturated fatty acids (linoleic acid) were found in all samples-1, 2 and 3. The higher saturated fatty acid of palmitic acid (16:0) (20.21%) in sample-1 than the other sample-2 (12.41%) and sample-3 (12.33%). A high dietary intake of saturated fatty acid is a risk factor for development of obesity, cardiovascular disease. The high content of monounsaturated fatty acid, oleic acid (18:1) (62.05%) was found in sample-1. Moreover, the amount of

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oleic acid (18:1) contains 40.51% in sample-2 and 42.51% in sample-3 respectively. The high content of monounsaturated fatty acids especially oleic acid is associated with a low incidence of coronary heart disease because it decreases total cholesterol (10%) and low-density lipoprotein cholesterol. The dietary intake of certain polyunsaturated fatty acids, in particular conjugated linoleic and fat-soluble antioxidants has been linked to potential health benefits.

4. CONCLUSION

In this research paper, the three peanut oil samples-1, 2 and 3 were carried out from three different oil factories in Shwebo for study the physicochemical properties. Each oil sample was analyzed by using standard analytical method. According to the results, the specific gravity of the oil samples was observed from 0.9533 to 0.9626. The highest % free fatty acid value of sample-2 is 6.5% and the sample-3 has the lowest % free fatty acid value of 2.4%. From the results, sample-3 has more edibility than the other two samples. Hence, the lower the free fatty acid the more acceptable the oil is to man in terms of palatability. Sample-3 and sample-1 have the lowest and highest peroxide values of 4 meq /kg and 6.8 meq /kg respectively. The peroxide value was found to have occurred around 2.5–5meq /kg oil which indicates a relatively good quality of these oils. The peroxide value determines the extent to which the oil has undergone rancidity. So, sample-3 is more suitable for long shelf life of oil than the others. The higher iodine value of sample-3 is 97 than the other samples. The low iodine values may have contributed to its greater oxidative storage stability. The oxidative and chemical changes in oils during storage are characterized by an increase in free fatty acid contents and a decrease in the total unsaturation of oil.

The highest iodine value indicates that the fatty acid presence is unsaturated especially oleic acid. The saponification value of oil samples are obtained from 192 to 202. The saponification value suggests that the mean molecular weight of fatty acids is lower or that the number of ester bonds is less. This might imply that the fat molecules did not interact with each other. Therefore, sample-3 has been more suitable for mass consumption and storage.

The fatty acid compositions of oil sample-1, 2 and 3 were determined by using Gas Liquid Chromatography (GLC). According to the results, all samples contain saturated fatty acid (palmitic acid), monounsaturated fatty acid (oleic acid) and polyunsaturated fatty acids (linoleic acid) were found in all samples-1, 2 and 3. The higher saturated fatty acid of palmitic acid (16:0) (20.21%) in sample-1 than the other sample-2 (12.41%) and sample-3 (12.33%). A high dietary intake of saturated fatty acid is a risk factor for development of obesity, cardiovascular disease. The high content of monounsaturated fatty acid, oleic acid (18:1) (62.05%) was found in sample-1. Moreover, the amount of oleic acid (18:1) contains 40.51% in sample-2 and 42.51% in sample-3 respectively. The high content of monounsaturated fatty acids especially oleic acid is associated with a low incidence of coronary heart disease because it decreases total cholesterol (10%) and low-density lipoprotein cholesterol. The polyunsaturated fatty acid (especially linoleic acid) was present in sample-2 and sample-3. The linoleic acid (18:2) content 36.47% in sample-2 and 35.96% in sample-3 were observed. The dietary intake of certain polyunsaturated fatty acids, in particular conjugated linoleic and fat-soluble antioxidants has been linked to potential health benefits. So, oils are important nutrients and energy sources that are most composed of triacylglycerol. Dietary triacylglycerol are composed of fatty acids that may vary in their chain length, degree of unsaturation, isomeric orientation of double bond and position within the triacylglycerol molecule. Peanut oils contain a high proportion of palmitic acid as well as considerable quantities of oleic and linoleic acids which give it higher unsaturated fatty acid content.

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