Evaluation of Saponification value, Iodine value and Insoluble impurities in Coconut Oils from Jomoro District in the Western Region of Ghana

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ABSTRACT---- ***Saponification value (SV), Iodine value (IV) and Insoluble impurities are some important parameters usually considered in the determination of coconut oil quality. The present study evaluated these parameters in coconut oils produced in the Jomoro District of the Western Region of Ghana. Three samples of coconut oils were collected from each of the four (4) major processing centres namely Ezinlibo (EZN), Kabenla-Suazo (KAB), Nawuley (NAW) and Nuba (NUB) in Ghana for quality evaluation. Three replicate titre values of each of the twelve (12) oil samples were obtained and the averages were taken into consideration. Laboratory analyses were conducted on the coconut oil samples collected from the processing centres and the results compared with two International Standards (Codex and APCC).The result showed that the mean SVs of oils from all the processing centres constituting 100% did not meet the APCC standards; however, 25% (NUB) were within the stipulated limits recommended by Codex. The mean iodine value (IV) of the oils from three centres (EZN, KAB and NAW) constituting 75% fell within the APCC while 25% (NUB) did not. For the Codex, 25% (NAW) met the standard while 75% (EZN, KAB and NUB) did not. Also, the amount of insoluble impurities found in oils from all the processing centres did not meet both the APCC and the Codex standards. The ANOVA at LSD (0.05) showed significant differences among the processing centres. The results imply that in general, the quality of coconut oils in terms of the parameters considered fell short of both the Codex and APCC standards. Therefore, further improved processes are required to enhance the quality of oils produced to meet the required international standards.***

Keywords--- Coconut oil, Processing centres, Quality, Parameters

1. INTRODUCTION

Coconut oil is used as edible oil, for medicinal and industrial purposes in Ghana and is largely produced in the Western Region of Ghana. Because of its domestic and industrial importance the standard of the oil should be ascertained to ensure its quality and safety for consumers. The quality of coconut oils can be influenced by several physical and chemical parameters that are dependent on the source of oil (geographic, climatic, genetic and agronomic) as well as processing and storage conditions [1]. Regardless of the sources of oil, processing and storage conditions, its quality must remain within the acceptable international standards. Among the quality parameters saponification value (SV), iodine value (IV) and insoluble impurities are of considerable importance as they measure the chemical nature of the oil and determine the final quality of the oil [1].

Saponification is the process of breaking down or degrading a neutral fat into glycerol and fatty acids by treating the fat with alkali. The saponification number (value) is defined as the milligrammes of potassium hydroxide (KOH) required to saponify 1g of fat. It is an index of average molecular weight of the triacylglycerols in the sample. The molecular weight of the triacylglycerols may be divided by three (3) to give an approximate average molecular weight of the fatty acid present. Kirk and Sawyer [2], reported that high saponification values of fats and oils are due to the predominantly high proportion of shorter carbon chain lengths of the fatty acids. This assertion was confirmed by Nielson [3], that the smaller the saponification values the longer the average fatty acid chain. If the fatty acids present in the glycerides are low molecular weight (short-chain acids), there will be more glycerides molecules per gram of fat than if the acids are high in molecular weight (long-chain acids). Thus, since each glyceride molecule requires three potassium hydroxide molecules for saponification, fats containing glycerides of low molecular weight correspondingly have higher saponification values [4]. Saponification values have been reported to be inversely related to the average molecular weight of the fatty acids in the oil fractions [5]. In combination with acid values; saponification

values are useful in providing information as to the quantity, type of glycerides and mean weight of the acid in a given sample. The saponification value of oils is of interest if the oil is going to be used for industrial purposes[6]. Saponification value is also used in checking adulteration. The larger the saponification number, the better the soap making ability of the oil [3]. Higher saponification value for triglyceride indicates higher medium chain fatty acids [7].Saponification value for unrefined vegetable oils may also be affected by the compounds in the nonsaponifiable fraction. For example, compounds such as phenolic acids that can react with KOH may also contribute to higher saponification value of coconut oils [7].

The iodine value is an identity characteristics nature of oil. The iodine value of an oil or fat is defined as the grams of iodine absorbed by 100g sample. The iodine value or iodine number is the generally accepted parameter expressing the degree of unsaturation, the number of carbon-carbon double bonds in fats or oils [8]. This value could be used to quantify the amount of double bond present in the oil which reflects the susceptibility of oil to oxidation. As the iodine is a measure for unsaturation of the fatty acids in the fat, the number of double bonds of a pure substance is:

$$\text{Double bonds} = \frac{\text{IV} \times \text{molecular weight of substance}}{253.84 \times 100}$$ [9].

The determination of the iodine value is also important in classifying oils and fats [7]. Classification of oils and fats as drying, semi drying and non-drying is given as follows: Drying oils: IV 200-130, Semi drying: IV 130-100 and Non-drying: IV lower than 100 [10]. The IV of free fatty acids is higher than that of glycerides. For each %FFA the IV increases by 0.00045×IV [9]. The higher the amount of unsaturation, the more iodine is absorbed: therefore, the higher the iodine value the greater the degree of unsaturation [3]. High iodine value indicates high unsaturation of fats and oils and low-IV oils are more saturated with fewer double-bonds [11]. Also higher iodine values are evidence that the oils could be used in the manufacture of cosmetics, oil paints and vanish, as well as nutritional purposes [11].

Insoluble impurities in oils and fats are generally defined as those materials which remain insoluble and can be filtered off, when the oil or fat is dissolved in diethyl ether or petroleum ether [9]. The nature of the impurities in vegetable oil foods renders them resistant to treatment by acids as in normal acidulation. Strong caustic soda solution was found to attack the gums and make them at least partially soluble in a 5 to 10% aqueous caustic solution [12]. Low level of insoluble impurities is a desirable characteristic in coconut oil.

The objective of this study was to evaluate the saponification value, iodine value and insoluble impurities of coconut oils produced in the Jomoro District of the western Region of Ghana and determine whether they meet international standards or not.

2. MATERIALS AND METHODS

Sample Collection

Three different samples of coconut oil (500mL per sample) were obtained in air-tight plastic containers from each of the four major coconut oil processing centres which were randomly selected. The oil samples were kept at room temperature of 25^{o}C and brought to the laboratory for analysis. A total numbers of twelve (12) oil samples were analysed. The collection was done between March and May. These processing centres include: Kabenla-Suazo (KAB), Ezinlibo (EZN), Nawuley (NAW) and Nuba (NUB) in the Jomoro District of the Western Region of Ghana.

Determination of Saponification Value (Number).

AOCS Method cd 3-25 (1993)[13]

A 0.002kg of the oil sample was weighed into a volumetric flask. Then 25mL of 1.0N alcoholic KOH was pipetted and allowed to drain for about 1 minute into the mixture. A condenser was connected to the flask and the mixture sample allowed to boil gently but steadily for 45 minutes for complete saponification. The flask and the condenser were then cooled but not sufficiently to form a gel, the inside of the condenser was washed down with about 1ml of distilled water. The condenser was disconnected and 1ml of phenolphthalein indicator added. The solution was titrated with 0.5N hydrochloric acid (HCl) until the pink colour just disappeared. A blank determination was conducted simultaneously with the sample. The saponification value was calculated using the formula below:

$$\text{Saponification Value} = \frac{56.1 \times N \times (V_2 - V_1)}{W}$$

Where, N = normality of HCl

V_1= volume of HCl used in the test, (mL)

V_2 = volume of HCl used in the blank, (mL)

W = weight of sample, (g)

Determination of Iodine Value

AOCS Method Cd 1-25 (1993)[13]

A 0.001kg of oil sample was weighed into a 500mL volumetric flask. 15mL of carbon tetrachloride was added to the sample and swirled to ensure that the sample is completely dissolved. 25mL of Wijs solution was then dispensed into the flask containing the sample using a pipette. The flask was stoppered and swirled to ensure complete mixing. The sample was then placed in the dark for 30 minutes at room temperature. The flask was removed from storage and 20mL of 10% potassium iodide (KI) solution added, followed by 150mL of distilled water. The mixture was titrated with 0.1N thiosulphate ($Na_2 S_2 O_3$) solution, adding gradually and with constant and vigorous shaking until the yellow colour had almost disappeared. 1.5mL of starch indicator solution was added and the titration was continued until the blue colour disappeared. A blank determination was conducted simultaneously. The iodine value was calculated using the formula below:

$$\text{Iodine value} = \frac{12.69 \times (V_2 - V_1) \times N}{W}$$

Where, N = normality of thiosulphate solution,

V_1 = volume of thiosulphate solution used in test

V_2 = volume of thiosulphate solution used in blank

W = weight of sample

Determination of Insoluble Impurities

The insoluble impurities were determined according to the method of [8]. A 0.002 kg of the oil sample was weighed into a 250mL conical flask and 20mL of 1:1 solvent mixture (petroleum ether + diethyl ether) was added. The flask was then shaken vigorously and allowed to stand for 30 minutes at 30^{o}C. The liquid was then filtered through a dried and weighed Whatman number 1 filter paper. The filter paper was carefully washed with 10mL of the solvent mixture. The filter paper was then dried to a constant weight in an oven at 103^{o}C. The increase in weight represented the weight of impurities and was expressed as a percentage of the initial sample as follows:

$$\%\,\text{impurity} = \frac{a}{w} \times 100$$

Where, a = increase in the weight of filter paper

w = weight of sample

Statistical Analysis

Data were analyzed using Statistical Package for Social Scientists (SPSS) and Excel (Microsoft Office 2013). The SPSS was used to run analysis of variance and the means compared using the least significant difference (LSD) at 5% to determine the significance levels of the parameters. Results obtained were compared with international standards. Codex Alimentarius 2005[14] and APCC standards were used for comparison.

3. RESULTS AND DISCUSSION

Saponification Value

According to Codex Alimentarius 2005 [14] and the APCC Standards, the saponification values (SV) range between 250-260 mg KOH/g oil and 248-268 mg KOH/g oil respectively. The result (Table 1) shows that the mean SVs of oil from all the processing centres (EZN, KAB, NAW and NUB) constituting 100% fell below the APCC minimum of 250mgKOH/g oil and thus did not meet the standard, however, 25% (NUB) were within the stipulated limits recommended by Codex whereas 75% (EZN, KAB and NAW) were not. The mean saponification value of oil from NUB was significantly ($p<0.05$) higher than that of oils from all the other processing centres (EZN, KAB and NAW) (Table 1). However, there was no significant difference between KAB and NAW. The low saponification values recorded in comparison with the APCC and Codex Alimentarius 2005 [14] might be due to high level of impurities as indicated by [15] that high saponification values recorded for almond seed oil suggested low level of impurities.

Table 1. Saponification values of coconut oils from four processing centres compared with APCC and Codex Alimentarius 2005 [14] standard ranges.

Processing centre (Oil Source)	**Mean Saponification Value (mg KOH/g)**	**APPC Standard (mg KOH/g)**	**Codex Alimentarius (2005) (mg KOH/g)**
EZN	246.83	250-260	248-268
KAB	247.50		
NAW	247.47		
NUB	248.42		

$LSD_{(0.05)} = 0.05$

Iodine Value

According to the Codex Alimentarius 2005 [14] and APCC Standards, the iodine values (IV) range between 6.3-10.6 and 4.1-11 respectively. The result (Table 2) indicates that the mean iodine value (IV) of the oils from three centres (EZN, KAB and NAW) constituting 75% fell within the APCC while 25% (NUB) did not. For the Codex, 25% (NAW) met the standard while 75% (EZN, KAB and NUB) did not. The mean iodine value of oil from NUB was significantly ($p<0.05$) higher than that of oils from all the other processing centres (EZN, KAB and NAW) (Table 2). There were no significant differences between oils from two of the processing centres (EZN and KAB). The iodine value or iodine number is the generally accepted parameter expressing the degree of unsaturation, the number of carbon-carbon double bonds in fats or oils [8]. Nielson [3], also reported that the higher the amount of unsaturation, the more iodine is absorbed; therefore, the higher the iodine value the greater the degree of unsaturation.

Table 2. Iodine values of coconut oils from four processing centres compared with APCC and Codex Alimentarius 2005 [14] standards ranges

Processing centre (Oil Source)	**Mean Iodine Value (mg KOH/g)**	**APPC Standard (mg KOH/g)**	**Codex Alimentarius (mg KOH/g)**
EZN	10.935	4.1-11	6.3-10.6
KAB	10.904		
NAW	10.062		
NUB	13.783		

$LSD_{(0.5)}$ =0.05

Insoluble Impurities

The maximum percentage by mass of insoluble impurities in oils according to both the APCC and Codex standards should not exceed 0.05%. The result (Figure 1) shows that the mean insoluble impurities of oil from all the processing centre (EZN, KAB, NAW and NUB) constituting 100% fell below the APCC and the Codex standard. The insoluble impurities of the oil from the EZN and NAW communities were significantly ($p < 0.05$) lower than those of KAB and NUB (Figure 1). Impurities are materials which remain insoluble and can be filtered off, when the oil or fat is dissolved in diethyl ether or petroleum ether [9]. The levels of impurities in all the processing centres were high. In fact, the amount of insoluble impurities is reflecting the efficiency of clarification during extraction of oil [16]. Field observations and interviews conducted during the study revealed that there were shortcomings in the way the filtration processes were carried out. While some centres were using woven materials others were using jute sacks as the filtering material. This might have accounted for the high levels of impurities in the oils from the processing centres as the filtering materials used were inefficient.

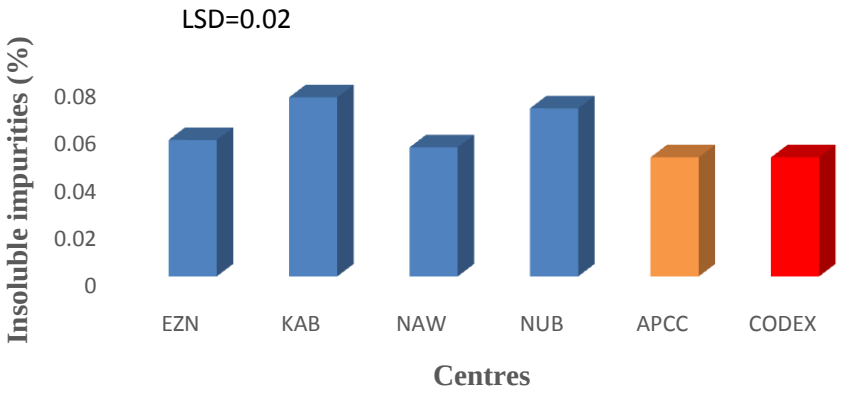

Figure 1: Mean insoluble impurities of coconut oil from the centres compared with that recommended by APCC and Codex

4. CONCLUSION

Saponification value (SV), iodine value (IV) and insoluble impurities are quality parameters which are of considerable importance in coconut oils. This study has shown that SVs of oil from all the processing centres did not meet the APCC standard; however, 25% met the Codex Alimentarius Standard. For the iodine value (IV), 75% and 25% of the oils from the processing centres met the APCC and the Codex standards respectively. Finally, the amount of insoluble impurities

found in oil from all the processing centres did not meet both the APCC and the Codex standards. The results imply that in general, the quality of coconut oil in terms of the parameters considered fell short of both the Codex and APCC standards. Therefore, further improved processes are required to enhance the quality of oil produced and bring it to the required international standard.

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