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Effect of Moisture Content on some Quality Parameters of Mechanically Expressed Neem Seed Kernel Oil

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ABSTRACT
The effect of moisture content on some quality parameters of mechanically expressed neem seed kernel oil was investigated. The quality parameters include saponification value, iodine value, fatty acid, acid value and colour. They were determined according to standard methods and were determined in three replicates. Matured neem seed kernels were obtained and the initial moisture content determined. The neem seed kernels were then preconditioned to the following moisture content values: 6.3, 8.1, 13.2 and 16.6 % (wet basis), based on reported values for oil seeds meant for oil extraction; the seed kernels were then subjected to oil extraction using an oil expeller. The oil obtained at the different moisture contents was then subjected to standard tests to determine the effect of these moisture contents on the quality parameters of the oil. New Duncan's Multiple Range Test (DMRT) was used to determine the differences in the mean treatment effect of moisture content on the different quality parameters. From the results obtained, highest saponification value of 262.46 was obtained with Moisture content at 8.1%, thereafter the saponification value decreased as the moisture content was increased. Iodine values increased as the moisture content increased from 6.1% to 8.1%, decreased sharply at 13.2% and then increased sharply at 16.6%. Moisture content seems to have increasing, decreasing, and then increasing effect on the values of the free fatty acid. Moisture content has an upward and downward effect on acid value. It was observed that moisture contents at higher levels affected the colour of the oil, which changed from brown to dark brown. From the foregoing, it can therefore be deduced that moisture content has an effect on the quality parameters of neem seed kernel oil.

KEYWORD: *Colour, free fatty acid, Moisture content, Neem seed kernel, Quality*

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I. INTRODUCTION

The neem tree is popularly known as *dongoyaro* in the Northern part of Nigeria where it grows in abundance. Neem's wide variety of reported benefits includes use in the treatment of fever, gastrointestinal disease, dermatologic (skin) disorder, immune dysfunction, respiratory disease, parasites, inflammatory conditions, and infections by some bacteria, fungi, and viruses. Some components have been shown to have antimalarial properties [1]. Some viral diseases that have been relieved through the use of neem include colds, flu and conditions caused by herpes such as chicken pox and shingles [2]. All parts of the tree have been reported to be very useful [3]. [3] also reported that the most famous part of the tree is the oil obtained from the seed kernel. Neem seed is a part of the neem tree which has high concentration of oil [4]. Neem seed contains 35-45% oil [5]. Neem oil is also used as a base for variety of organic cosmetics including soaps, shampoos, hand and body lotions and creams. It is also used as an organic bio-pesticide repellant against insects such as meal worms and aphids [6]. Neem oil is used for treating many skin diseases such as eczema, psoriasis (skin disease) and skin allergies [7]. Neem oil is considered as one of the most important of the commercially available product of neem for medicine and cosmetics. The yield and quality of the oil obtained by mechanical expression are affected by various operating conditions such as heating temperature, heating time, moisture content, applied pressure, particle size and pressing time [8]. Effect of different processing factors on yield and quality of oil from some oil bearing seeds have also been investigated by various authors; groundnut [9]; olive [10]; sesame seed [11]; palm kernel [12]; soyabean [13]; conophor nut [14], castor seed [15], neem seed [3].

II. MATERIALS AND METHODS

Mature and healthy neem seeds used for the experiments were obtained from Katsina Zonal Forest Office, Ministry of Agriculture and Natural Resources, Katsina State, Nigeria. The seeds kernels were sun dried for some days to allow for the easy removal of the seed kernels. The dried endocarp was cracked to obtain the seed kernels, after decortication, the hulls of the kernels and other dirt were removed by winnowing. An oil expeller was used in carrying out oil expression.

2.1 Moisture Content Determination

The moisture content of the seed kernel was determined according to [16] standard for oil seed. Three samples each weighing 15g were placed in an oven set at 105^0C for 24hours.The samples were then cooled, weighed and the moisture content calculated. Loss in weight is assumed to be moisture loss. Initial moisture content of the seeds was 8.1%. The sample was divided into four parts; one part (one-fourth) was left as it was; while the remaining part was sun dried at 34^0C for 12 hours to further reduce the moisture content to 6.3%. This sample was further divided into three parts, one part (one-third) was left as it was; while the remaining part was further conditioned to desired moisture content levels as described by [12]. Adding distilled water as calculated from equation 1 increased the moisture content of the seed kernels.

$$Q = \frac{A(b-a)}{(100-b)}$$ [12]

1

Where:
A = Initial mass of the sample
a = Initial moisture content of the sample, % wb
b = Final (desired) moisture content of sample % wb
Q = Mass of water to be added kg

Each sample was sealed in a separate polythene film. The samples were kept at 5^0C in a refrigerator for a week to enable the moisture to distribute uniformly throughout the samples. The four moisture content levels that were prepared are: 6.3% wb, 8.1% wb, 13.2% wb and 16.6% wb.

The oil was expressed using a National Cereals Research Institute (NCRI), Badeggi, Niger State, Nigeria developed oil seed expeller (Plate 1). The expeller capacity ranged from 15-20 kg/h and was powered by a 7.5kW, 3 phase electric motor with in-built reduction gear. It was run at 75 rpm. Experiments were conducted at moisture contents of 6.3, 8.1, 13.2 and 16.6% wb. Oil Expressed and cakes from the samples were collected separately. Cleaning of the expeller barrel was done after each expression. Three replicates of the experiments were done.

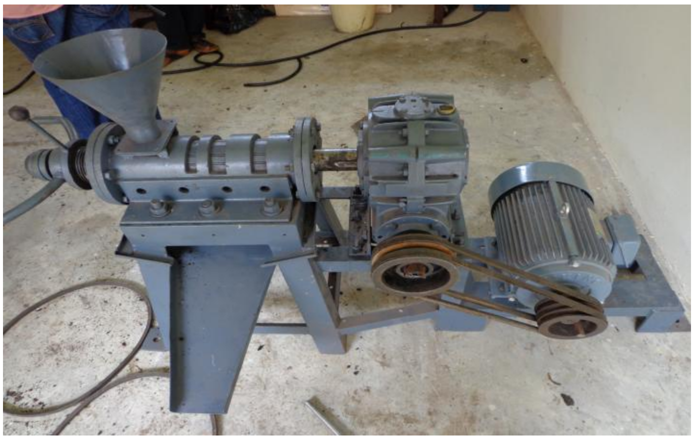

Plate1: Oil Expeller

2.2 Determination of Oil Quality

The following parameters were used to determine the quality of the oil expressed. They are Saponification value, Iodine value, free fatty acid value, Acid value and colour. They were determined according to the methods described by [17] and [18]. They were determined in three replicates.

III. RESULTS AND DISCUSSIONS

The results obtained were subjected to New Duncan's Multiple Range Test to determine the differences in the mean treatment effect of moisture content on the quality parameters of oil as shown in Tables 1 to 5.

3.1 Saponification Value

Table 1 shows the comparisons of saponification value between the different levels of moisture contents using the New Duncan Multiple Range Test (DMRT).

Table 1: New Duncan Multiple Range Test for Saponification Value at various moisture contents

Moisture content	Saponification value
6.3	255.48a
16.6	259.41b
13.2	260.09c
8.1	262.46d

Means with the same alphabet are not significantly different from each other

In comparing the means of Saponification Value at the four levels of moisture content, higher Saponification Value of 262.46 was obtained with Moisture content at 8.1%. The Saponification Value decreases thereafter as the moisture content was increased.

Figure 1 shows the graphical illustration of the effect of moisture content on saponification value. As seen in the preceding argument, Saponification value increased sharply from moisture content 6.3 to 8.1% and then dropped progressively. Saponification value is an indicator of the average molecular weight and hence chain length. It is inversely proportional to the molecular weight of the lipid [19].

High saponification value of fats and oils are due to the predominantly high proportion of shorter carbon chain lengths of fatty acids [20]. Low molecular weight (short to medium chain) fatty acids have more glyceride molecules per gram of fat than high molecular weight acids. Each glyceride molecule requires three KOH molecules for saponification, hence the more the glyceride molecules the greater the saponification value [21] as cited in [22].

According to [23], saponification value in combination with the acid value provides information on the quantity, type of glycerides and mean weights of the acids in a given sample. Saponification value is of interest if the oil is for industrial purposes, as it has no nutritional significance [24]. The larger the saponification number, the better the soap making ability of the oil [25].

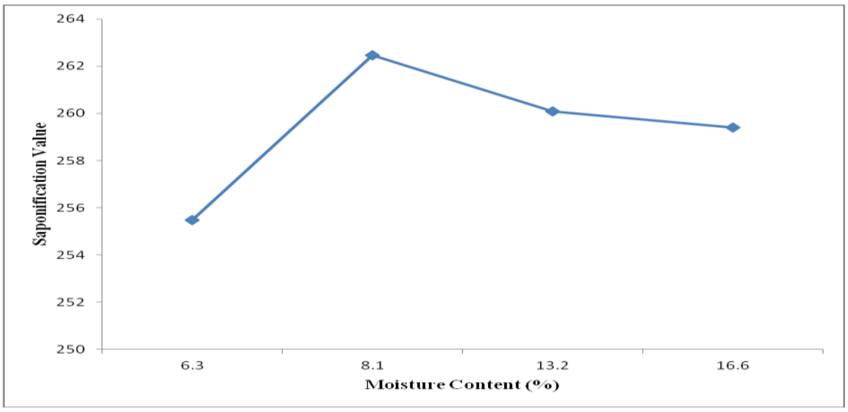

Fig.1: Effect of Moisture Content on Saponification Value

3.2 Iodine Value

The new Duncan Test (Table 2), revealed where the significant differences in the levels of moisture content on iodine value lies.

Table 2: New Duncan Multiple Range Test for Iodine Value at various moisture contents

Moisture content	Iodine value
6.3	75.23a
13.2	75.38a
8.1	76.05b
16.6	77.07c

Means with the same alphabet are not significantly different from each other

Table 2 showed that Moisture content at 16.6% recorded significantly higher Iodine value compared to all other levels of moisture content used in the experiment. A minimum of 75.23 Iodine value was observed at 6.3% moisture content which is the lowest moisture content used for this experiment. Figure 2 show Moisture content having a standing S shaped curve. Iodine values increased as the moisture content increased from 6.1% to 8.1%, decreased sharply at 13.2% and then increased sharply at 16.6%.

The iodine value is a measure of the degree of unsaturation in oil and could be used to quantify the amount of double bonds present in the oil which reflects the susceptibility of oil to oxidation. The behaviour of the iodine value noticed earlier may be as a result of oxidation and hydrolysis [26]. [27] reported that there are many factors that accelerate the oxidation process, this include high temperature and metal content. During the extraction, there is possibility that some amount of metal (Fe) from the pressing plates may have been introduced into the extracted oil. It can also be observed that the values obtained for iodine values (75.23-77.07g/100g) falls within the range of values (68.98–92.90g/100g) reported by [26]. Other authors reported the following values for similar seed oils; 41.3mg/100g for cashew nut oil [28], 15.10mg/100g for *L. owariensis* [29] and 9.93 mg of I g^{-1} of oil for coconut oil [30].

Iodine value is useful in predicting the drying property of oils and the low values observed indicates that the oil obtained in this study is non- drying. Low iodine number implies the presence of few unsaturated bonds and hence low susceptibility to oxidative rancidity [31]. Therefore, the lower the iodine value, the lower the degree of unsaturation and hence the lower the tendency of the oil to undergo oxidative rancidity.

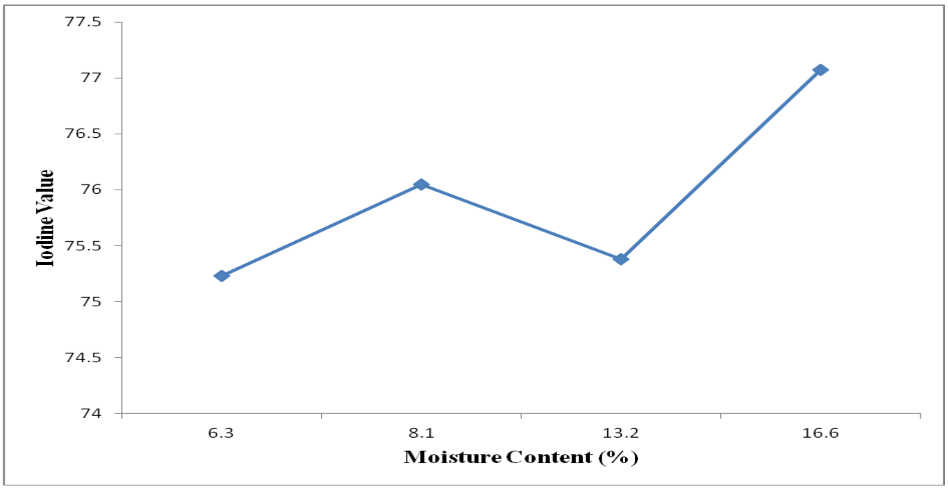

Fig.2: Effect of Moisture Content on Iodine Value

3.3 Free Fatty Acid

Table 3 shows where the significant differences in the different levels of moisture content on free fatty acid lies.

Table 3: New Duncan Multiple Range Test for Free Fatty Acid at various moisture contents

Moisture content	Free fatty acid
6.3	13.12a
13.2	14.50b
16.6	17.37c
8.1	17.42c

Means with the same alphabet are not significantly different from each other

Moisture content at 8.1% and 16.6% recorded statistically the same value for free fatty acid (17.42 and 17.37 respectively). These values were significantly higher than those observed at 6.3% and 13.2% respectively.

Figure 3 shows the graphical illustration of the observed free fatty acid values at the various levels of moisture content studied. Moisture content seems to have increasing, decreasing, and then increasing effect on the values of the free fatty acid. This phenomenon may have been caused by the hydrolysis process which occurred in the oil and may have been caused by water and lipase enzymes [26]. [27] and [32] also reported that during extraction of oil from oil seeds, water inside the seed bed flows out along with the oil and reacts with triglycerides to form free fatty acids and glycerols.

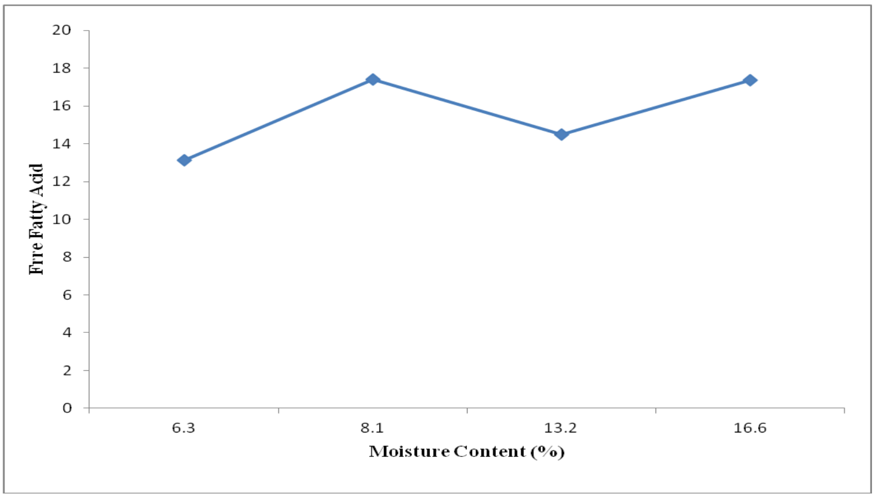

Fig. 3: Effect of Moisture Content on Free Fatty Acid

3.4 Acid Value

Duncan Multiple range test was used to investigate the significant differences in acid value between the levels of moisture contents.

Table 4: New Duncan Multiple Range Test for Acid Value at various moisture contents

Moisture content	Acid value
6.3	21.59a
16.6	23.74b
8.1	23.99c
13.2	24.39d

Means with the same alphabet are not significantly different from each other

Moisture content at 13.2% recorded acid value of 24.39 which is statistically higher compared to all the other levels of moisture content.

Fig.4 shows that moisture content has an upward and downward effect on acid value. Oxidation and hydrolysis processes occurring in neem seed oil reduced the amount of unsaturated fatty acids which led to an increase in the acid value [26].

Hydrolysis occurs as a result of water content and the activity of enzymes. Acid value was higher for *dika* oil expressed from the dika meal at 9% moisture content than for the oil expressed from the samples at 3% moisture content [33]. Thus the higher acid values observed in higher moisture content was probably due to the presence of water that caused hydrolysis and aided the degradation of the oil according to [34]. The downward trend with the lower moisture content might be associated with the increased deficiency of moisture required to support lipase activity, as suggested for palm oil [35].

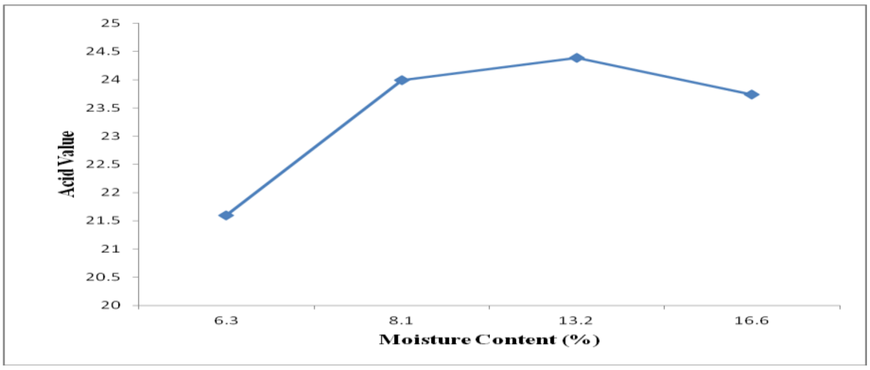

Fig. 4: Effect of Moisture Content on Acid Value

3.5 Colour

Table 5 shows the differences in the colour of oil expressed at the various levels of moisture contents.

Table 5: New Duncan Multiple Range Test for colour at various moisture contents

Moisture content	Colour	Mode
6.3	3.492a	3
16.6	3.590b	4
13.2	3.643b	4
8.1	3.645b	4

Means with the same alphabet are not significantly different from each other

It was observed that moisture contents at higher levels affected the colour of the oil, which changed from brown to dark brown. [11] also reported that colour intensity of palm kernel and sesame oils increased with increase in moisture content.

Figure 4.6 is a graphical illustration of the effect of moisture content on the colour of the expressed oil.

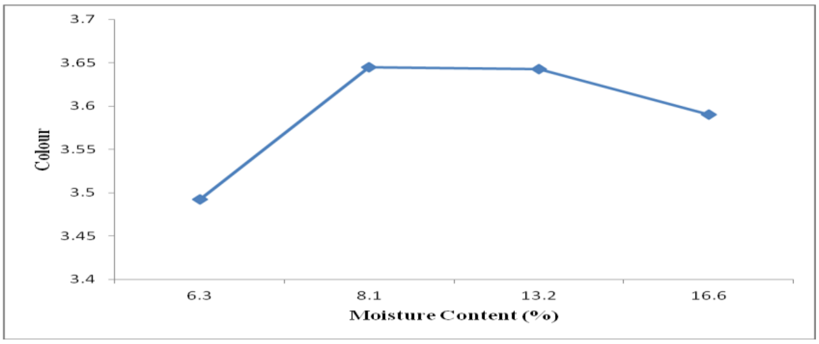

Fig.5: Effect of Moisture Content on Colour

IV. CONCLUSION

According to previous work done by researchers, the quality of oil obtained by mechanical expression are affected by various operating conditions such as heating temperature, heating time, moisture content, applied pressure, particle size and pressing time. The effect of one of these operating conditions (moisture content) was therefore investigated. From this study, it can therefore be concluded that the various moisture content s at which the neem seed kernels were expressed affected the quality of the expressed oil. All the quality parameters investigated in this work were affected by the different levels of moisture content.

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