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# Predicting Models for Lipid and Proximate content of Tyger nut at varying Temperatures

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***Abstract:*** *Tiger nut is known for its numerous uses such as food for man, medicinal and stimulant properties, rich sources of nutrients, mineral and lipids which is responsible for its energy giving ability. In Nigeria, people consume tiger nuts in both fresh and dried forms and the argument of which forms gives better nutritive value always arises due to the difference in the hydrated and dehydrated forms of the tiger nut caused by drying of the nuts. This research work predicts model equations on how varying temperature (25°C, 40°C, 60°C, 80°C, 100°C) affects the lipid and proximate content of Nigerian based tiger nuts. From the experiment carried out, it was found that lipids, fiber and moisture in tiger-nuts respond to temperature in a non linear decreasing manner with a polynomial form of fourth degree and model predictions of 1. This showed that changing temperature affects the lipid, moisture and fiber content of the tiger nuts from room temperature (25°C) which represents fresh nuts composition to 100°C in polynomial forms.The ash content increases non linearly with increased temperature in polynomial form. These polynomial equations can be used as models for predicting and designing tiger nut plants within the specified temperature range (25-100°C).This results also suggest that consuming the tiger nuts in fresh form gives more lipid, moisture, fibre content with other nurtitive and medicinal properties compared to dried form.*

**Keywords—** Tiger nuts; Lipids and Moisture; ash and Fiber content; Model prediction; Temperature

## 1. INTRODUCTION

Tiger-nut (Cyprus esculentus) is a crop which belongs to the division magnolophyta, class liliosida, order cyperales and family cyperaceae and also found to be a cosmopolitan perennial crop of the same genus as the papyrus plant [1]. Tiger-nut is an ancient food source known to humanity, and also used as sexual stimulant in parts of the world, although no scientific evidence has shown its potential sexual stimulant qualities [2].

The plant is rich in nutritional contents such as lipids, carbohydrates and minerals which are valuable to humans and animals [2]. It has lots of health benefits when consumed since it cures variety of sickness in the body and also prevents heart attack diseases, thrombosis, and helps to activate blood circulation [3]. It also reduces the risk of colon cancer [4]. The plant tuber is also rich in energy content such as: starch; lipid; sugar; and protein. They also contain minerals such as phosphorus, and potassium, vitamins such as vitamin C and E [1]. The tubers of tiger nut are also suitable for diabetic patients and for weight reduction [5].

The juice extract from tiger nut is used in producing tiger-nut milk which is rich in calcium and is responsible for bone development in infants when consumed. The milk also contains zinc, quercetin, vitamin C and vitamin E which are vital for boosting both male and female fertility. In addition to its medicinal qualities, Tiger-nuts is also a very good source of lipid which is soluble in nonpolar solvents and comprises of a group of naturally occurring molecules that include fats, waxes, sterols, fat-soluble vitamins (such as vitamins A, D, E, and K), monoglycerides, diglycerides, triglycerides, and phospholipids [6][7]. The main biological functions of lipids include storing energy, signaling, and acting as structural components of cell membranes [7][8]. Lipids have applications in the cosmetic industries due to the presence of vitamin A and E which helps to slow down aging process and favor elasticity of the skin and reduces skin wrinkles [9]. Research has shown that tiger-nuts are used in the treatment of flatulence, diarrhea, dysentery, debility and indigestion [9-10]. Other research work carried out on tiger nuts are focused on the use of the nuts for oil production [11-15], food and animal feed [16-18], milk production [19-20], chemical and proximate compositions [21-23].

This research paper looks at how the lipid, fiber, moisture and ash content in tiger nut rich in vitamin C and E varies with changing temperature and predicting models relating this changes. Fig. 1 (a) and (b) shows the image of the dehydrated (dried) tiger nuts and hydrated tiger nuts (fresh) respectively.


Figure 1 a (dehydrated) and b (hydrated)

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## 2. MATERIALS AND METHOD

### 2.1 Materials

Electric drying oven (W.T.C. Binder (350°C)), Weighing balance (Scientech digital (0.01g-210g)), Crucible, Conical flasks (250ml), Soxhlet extractor and thimbles, Rotary evaporator (Buchii Product), Desiccator, Beakers (250ml and 500ml.), Buchner funnel and suction pump, Muffle furnace (1000°C), Pressure boiler (700°C), Desiccator, 40% and 2M Sodium Hydroxide (NaOH) solution , Petroleum ether (Variable boiling range.), Concentrated Sulfuric acid (0.1M and 2M), Boric acid (0.1M), Methyl red/methylene blue (mixed indicator), Hydrochloric acid (0.1M), Sodium sulphate ($Na_2SO_4$ crystals), Copper sulphate ($CuSO_4$ crystals)

### 2.2 Method

The methodology adopted in this research work was based on the research procedures of Association of official agricultural and analytical chemists [24-25]. All procedures were carried out in triplicates for efficiency.

#### 2.2.1 Procedure for moisture content

A clean porcelain crucible with lid was dried in an oven for 8 hours to obtain a constant weight (a) = 10grams. 5grams of the sample was introduced into the crucible, the lid replaced and weighed to obtain the weight (b) = 15grams. The crucible with content was placed in the oven and the temperature set at 40°C, 60°C 80°C and 100°C for 24 hours each after leaving it at 25°C for 24 hours. The subsequent products were later allowed to cool in a desiccator and weighed to have a constant weight (c). Equation (1) was applied to calculate the percent moisture content of the tiger nut.

$$\%\ \text{Moisture} = \frac{b-c}{b-a} \times 100 \qquad (1)$$

#### 2.2.2 Procedure for ash content

2grams of oven dried sample was weighed in a crucible of known weight (10grams). The crucible and content were placed in a muffle furnace and ignited at 25°C, 40°C, 60°C, 80°C and 100°C for 15hrs each. The samples were then cooled to room temperature in a desiccator and equation (2) was used in calculating the ash content of the nuts.

$$\%\ \text{Ash} = \frac{\text{Weight of ash}}{\text{Weight of dried sample}} \times 100 \qquad (2)$$

#### 2.2.3 Procedure for lipid content

5gram of oven dried sample were accurately weighed into a thimble, 200ml of petroleum ether was poured into a previously weighed round bottom flask containing weighed anti bumping granules. The soxhlet extractor and the thimble with its content were fitted into the flask and the set up was placed on a heating mantle. The flask was heated slowly through 25°C 40°C, 60°C, 80°C and 100°C on the heating mantle until the solvent in the extractor turns colourless. The thimble was removed and air dried at every required temperature. The extracted lipid in the flask was concentrated using rotary evaporator. This was further dried in a desiccator and then weighed. The amount of lipid extracted was obtained from the difference between the weight of the flask before and after extraction. The equation (3) was applied to determine the percent lipids in the nuts.

$$\%\ \text{Lipid} = \frac{\text{Weight of extract}}{\text{Weight of sample}} \times 100 \qquad (3)$$

#### 2.2.4 Procedure for fiber content

Acid digestion was carried out by weighing 2gram of fat free sample and quantitatively transferred into a 500ml beaker which has a mark at the 200ml line. 50ml of 1.25% $H_2SO_4$ was added and the mixture made up to 200ml mark with distilled water. The content in the beaker was then boiled for 30 min. The content of the beaker were filtered through a Buchner funnel with the aid of a suction pump. The residue was washed severally with hot water until it was acid free. The residue was then transferred into the 500ml beaker and 50ml of 1.25% NaOH solution was added and made up to the 200ml level with distilled water. The mixture was brought to boiling for 30min with stirring. The content were filtered through a Buchner funnel and washed severally with hot water until it was free from NaOH. Finally the residue was washed with 95% ethanol twice and transferred into a porcelain crucible and dried at 100°C.

This procedure was carried out for different temperature of boiling, for 25°C (using pressure boiler), 40°C, 60°C, 80°C and 100°C. The percentage fiber of the nuts was obtained from equation (4).

$$\%\ \text{Fiber} = \frac{\text{Weight of dried fiber}}{\text{Weight of free fat sample}} \times 100 \qquad (4)$$

## 3. RESULT AND DISCUSSION

The result in table 1 shows that the moisture content (M), fiber (F) and lipid (L) decreases with increasing temperature while the ash (A) content increases. The results in the table are the average of the triplicate experiment carried out on the tiger nuts. Although previous work on proximate analysis of tiger nuts [9-10] which did not vary temperature range, showed large difference in the results compared to ours, this is best understood due to the large variation in moisture content of the tiger-nuts as obtained and used for the research by the various researchers. The results in table 1 varied the proximate analysis with temperatures. This result sequence is corroborates by the graphs in Fig. 1, 2, 3 and 4

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for moisture, ash, lipid and fiber content respectively.

**Table: 1** Average percentage proximate analysis and lipid data for the tiger nuts analysis

| Temp (°C) | % M | % A | % F | % L |
|---|---|---|---|---|
| 25 | 73.48 | 1.21 | 5.44 | 4.42 |
| 40 | 69.55 | 1.22 | 5.30 | 4.29 |
| 60 | 50.45 | 1.44 | 5.13 | 3.61 |
| 80 | 38.95 | 1.93 | 4.98 | 3.29 |
| 100 | 22.38 | 2.01 | 4.31 | 2.42 |

Figure 1 and 2 shows the graphical presentation of the percent moisture content and ash content respectively.

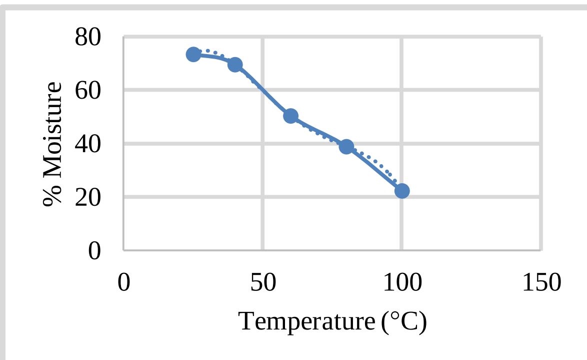


Fig. 1 Percentage moisture against temperature

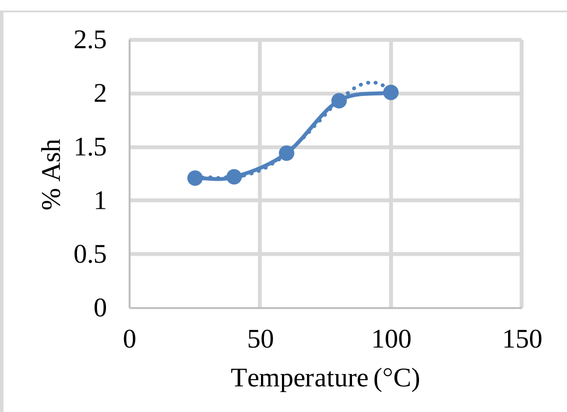


Fig. 2 Percentage ash against temperature

The graph on Fig. 1 predicts the moisture content to decrease non-linearly as temperature increases with a model equation as shown in (5).

$$\% M = -1e^{-05}T^4 + 0.0027T^3 - 0.2447T^2 + 8.4367T - 22.722 \quad (5)$$

The decrease is polynomial in nature and has reliability of the Model Prediction $R^2 = 1$. Reliability of the Model Predictions is perfect when $R^2$ is unity and this shows that the model perfectly predict the behavior of the moisture content of the tiger-nuts considered in this research work with temperature.
The variation of moisture content in the tiger nuts with temperature is best understood with the phenomena of evaporation as most of the moisture content of tiger-nut evaporates as its being heat treated in an oven. This is accompanied with a decrease in density of the tiger-nut and also its softness.
Figure 2 showed that the ash content increases non-linearly and in polynomial form as temperature increases. The model equation for the graphical plot is shown in (6)

$$\% A = -2e^{-07}T^4 + 4e^{-05}T^3 - 0.0028T^2 + 0.075T + 0.4866 \quad (6)$$

And has reliability model prediction of ($R^2 = 1$). This is true since ash helps increases pH and also contains elements such as potassium, calcium and this model is a clear indication that there's an increase in these values of tiger-nuts as they are being converted to ash with an increase in temperature of burning. Fig. 3 shows the variation of lipid content in tiger nuts at varying temperatures. The prediction model equation is shown in (7)

$$\% L = -5e^{-07}T^4 + 0.0001T^3 - 0.0114T^2 + 0.387T - 0.041 \quad (7)$$

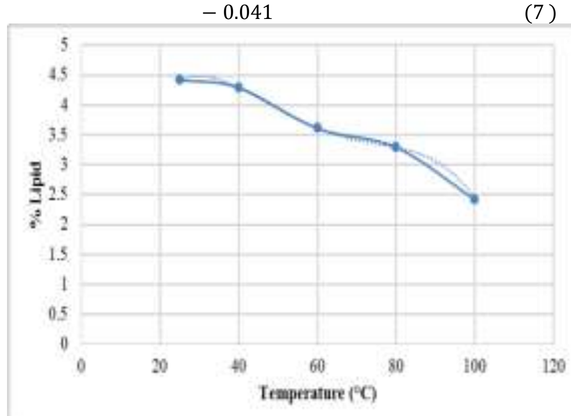


Fig.3 Percent lipid against temperature

The trend predicted from the graph for the variation of lipid content with temperature shows a non linear response of lipid to temperature and it is a polynomial of the power of 4. The test for realiability of the model $R^2$ was unity, this is a clear indication that the response of lipid to temperature decreases in a non linear manner. This indicates that the components of lipids such as glyceride in the tiger nuts decomposes and also free fatty acid formation responsible for energy storing ability of the nuts decreases. This also decreases sterols which plays major role in cholesterol reduction, rancidity and increase the shell life of tiger nut. Thus dried tiger nuts has longer shelve life compared to the fresh ones but less energy capability and medicinal property. All of these contributes to the non linear polynomial behavoiur of lipid with temperature. It was also observed that every significant increase in temperature also favoured the aroma of tiger-nut and as a result giving it a good market value when needed for its aroma in preparation of snacks and foods.

Fig. 4 shows the graphical presentation of variation in fibre content of tiger nuts at varying temperatures.

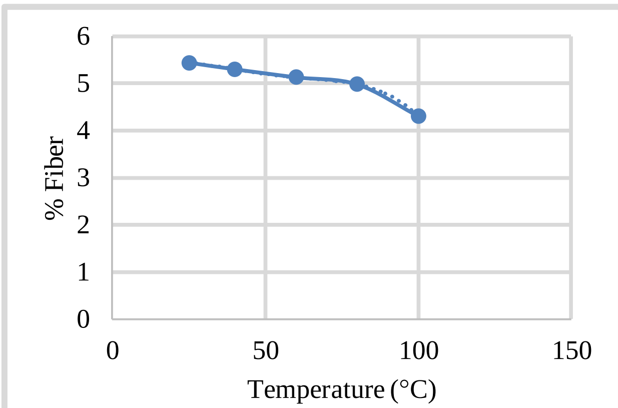


Fig. 4 Percentage fiber against temperature

The % Fiber in tiger-nut decreases non-linearly with a significant increase in temperature, this is as a result of some of the tiger-nuts changing into ash as temperature increases, as predicted in the model equation in equation (8) with reliability of the model prediction of $R^2 = 1$.

$$\% F = -2e^{-07}T^4 + 3e^{-05}T^3 - 0.0022T^2 + 0.0577T + 4.9691 \quad (8)$$

As a result, and from the model, % Fiber tends to zero non-linearly as temperature increases.

## 4. CONCLUSION

From this research work , it is justifiably to say that lipids in tiger-nuts, respond to temperature in a non linear decreasing manner with a polynomial form of fourth degree and model prediction of 1. This indicates the perfect explanation of how the changing temperature affects the lipid content of the tiger nuts. Also the moisture and fibre content of the tiger nuts decreases with increasing temperature with non linear polynomial model equation and model prediction of 1. While the ash content increases non linearly in polynomial form with increased temperature. This model equations can be used for predicting future tiger nuts properties and design of a tiger nuts plant within the this temperature ranges. From this research work it can be recommended that consuming fresh tiger is more beneficial than the dried form for its nutrients, medicinal and energy storing ability. Although depending on the use of the tiger nuts, heat treating is required to reduce its acid value and to reduce rancidity if used for its oil.

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