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Experimental Determination of the Effects of Pre-treatment on the Nutritional Quality of Cocoyam Chips.

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ABSTRACT

This paper presents the experimental determination of the effect of pre-treatments on the quality of cocoyam, with emphasis on the fundamental nutritional contents of cocoyam chips. The proximate composition of the sliced samples were determined using gravimetric method for moisture content, and AOAC methods for ash content, crude protein, fat content, crude fibre and carbohydrate content. Cocoyam sample replicates were subjected to three different treatments of blanching, steeping and natural state (control) before being dried at levels of oven temperatures (50^0c and 70^{oc}). The results indicated that the protein, fat, ash, crude fibre and carbohydrate contents ranged between 2.1 – 5.6%, 1.5 and 27%, 2 and 4.5%, 1.5-9.5%, 23.7% and 43.25% respectively.The ANOVA outcomes obtained with respect to the different treatments and temperatures indicated that there was a significant difference ($P< 0.05$) in the nutritional content of the cocoyam slices. More so, there was a huge difference between the steeped sample dried at 50^0C and the steeped sample dried at 70^0C. For the pre-treatment method that preserves nutritional and functional values, samples that were steeped and oven-dried at 50^0C gave better results for protein. The blanched dried sample at 50^0C gave more desirable result for fat result while the untreated dried sample at 50^0C gave better crude fibre result. It is therefore concluded that the pre-treatment of cocoyam chips has an effect on its nutritional quality. With the outcome of this study, it becomes imperative to recommend that an optimal oven temperature of 50^oC and blanching treatment be used to process and maintain the nutritional contents of cocoyam for secondary products applications.

Keywords: *Cocoyam chips, Nutritional quality, Pre-treatment, Proximate composition, Blanch & Steep.*

INTRODUCTION

Cocoyam is a stem tuber and herbaceous perennial plant belonging to the Araceae family and constitutes one of the six most important roots and tuber crops world-wide. It is also a nutritious tuber vegetable plant that is eaten in many different cultures around the world (Nwagbo, 2011). It ranks third in importance after yam and cassava in extent of production among the root and tuber crops of economic value in Nigeria and is in direct competition with cassava and yam as food.

The major cocoyam producing areas are located in the humid zones and the production lie on small farmers having 0.5 – 2.0 ha in production (Enwelu, *et al.*, 2014; Balami, *et al.*, 2016). The two species mostly grown in West Africa are *Colocasia esculenta* and *Xanthosoma sagittifolium*. Findings from extensive researches have revealed that cocoyam remains an indispensable but yet neglected food crop, especially for predominantly malnourished households in many developing countries like Nigeria (Aderolu, *et al.*, 2009).

Nutritionally, cocoyam is composed of 70-80% water, 20-25% starch and 15-30% protein (Azeez and Maduekwe, 2010). According to Nwagbo (2011), taro specie (*Colocasia*) contains some calcium, vitamin C, vitamin E and B vitamins, as well as magnesium, manganese, copper and fiber. The preeminence in digestible starch (98.8%), size of starch grain (1/10th of potato), sulphur amino acid content and price per tonne have continued to position cocoyam as a better choice than cereals in feed, food products and food supplement production (Enwelu, *et al.*, 2014; Balami, *et al.*, 2016). The high concentration effect of the abounding contents of cocoyam could be refined through different heat treatments to obtain an excellent source of carbohydrate, vitamins and minerals (Abdulrashid and Agwunobi, 2009).

The high susceptibility of cocoyam to spoilage at post-harvest stage has continued to trigger researches on best treatment and processing practices to convert cocoyam to more stable forms that will increase the storage shelf-life. Cocoyam can be processed in several ways to produce food and feed products of diverse applications. The corms are consumed by humans after subjecting them to such heat treatments like boiling, blanching, steaming, stewing, frying and pressure cooking. These methods are found to be effective in improving digestibility, increasing nutrient bio-availability and also minimizing anti-nutritional factors and food-borne diseases (Soudy *et al.*, 2010). The processing of cocoyam corm affects its proximate composition, mineral content, phytochemical components and anti-nutrient (oxalate and phytate) contents. As a guide to sustain the nutritional endowments of tuber crops like cocoyam, there is usually a need to experimentally study the impact of treatments on the quality of whole, chipped or milled cocoyam product. In view of this, this study aims at the determination of the effect of pre-treatment on the nutritional quality of cocoyam tuber, with emphasis on the fundamental nutritional contents of cocoyam chips. The study is experimental and descriptive. In this study, cocoyam sample replicates would be subjected to three different treatments of blanching, steeping and natural state (control) before being dried under two levels of temperature levels of oven temperatures (50^0c and 70^{oc}), and then the effects of the treatments on the proximate contents of the cocoyam chips would be compared.

EXPERIMENTATION

2.1 Materials

Fresh corm of cocoyam (*colocasia esculata*) was purchased from Eke market, Ekwulobia, Aguata Local Government area, Anambra State, Nigeria. The materials, equipment and reagents used for the analysis were those available at the analytical laboratory of spring board laboratory, Awka Anambra, State.

2.2 Samples Preparation

The cocoyam corms (2kg) were peeled with a stainless knife, washed and sliced into pieces of 3.5 ± 0.2mm thickness. 500g was soaked in water for 2 days, another 500g was blanched and another 500g was left in its natural state after peeling without any form of treatment. The three samples were dried using an oven dryer at 50°C and 70°C respectively. The dried samples were packaged in an airtight polythene bag and properly labeled for laboratory analysis.

2.3 Pre-treatment of samples

Three levels of pre-treatment which include natural state (control), steeping and blanching the root crop (cocoyam) were applied before drying the chips to know its effects on the nutritional values of the food material at different temperatures. The treatment rates were conducted at two temperatures of 50^0C and 70^0C which were applied to each sample for a period of between one hour and 6 hours to know the effect of pre-treatment on each sample. Three replicates of the treatments were used for the experiments to reduce the random error.

2.4 Proximate Composition Analysis of Samples

The chemical composition of food are all potentially significant as they determine the safety, nutritional value sensory attributes and suitability for use in particular products and processes. The determination of agricultural and food products composition is fundamental to theoretical and applied investigation in food content experimentation and technology and is often the basis of establishing the nutritional value and overall acceptance from the consumer standpoint. Proximate analysis of food products is the determination of the constitutional make-up of the major nutritional components like moisture, ash, crude fat, protein, crude fibre and carbohydrates. The following protocols were adopted for the proximate composition analysis of samples.

i. The moisture content was determined using the gravimetric method (AOAC, 1990).

ii. The AOAC (1990) furnace incineration gravimetric method was used for the ash content determination.

iii. Crude protein content was determined by the AOAC (1990).

iv. The fat content of the samples was determined by the AOAC (1990).

v. The AOAC method was used for crude fibre determination.

vi. Carbohydrate content was determined by constitutional difference method describe by AOAC (1990)

2.5 Determination of Moisture Content

The determination of moisture content is one of the most important and widely used measurements in samples that absorb and retain water. Chemical analyses are normally made on dry matter basis. The sample dishes (aluminum or plastic) were washed thoroughly, dried and weighed for initial weight. The food samples were adequately mixed and put into the weighed dish, and the weight taken (in duplicate). They were then dried in the moisture oven at 70 – 80°C for 2hours and at 100 – 135°C (usually 105°C) for the next 4 hours or until weight is constant. Using a dessicator, the dried samples were allowed to cool after which the dry weight was determined. The percentage of moisture content were calculated using;

$$\text{Percentage Moisture} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \qquad (1)$$

Where: W_1 = initial weight of empty crucible; W_2 = Weight of crucible + food before drying; W_3 = Final weight of crucible + food after drying.

And the Percentage Total solid (dry matter) = 100 - % moisture.

2.6 Determination of Crude Fibre

Crude fibre may be defined as the sum of all organic components of the plant cell membrane and supporting structures which in chemical analysis of plants and animals remain after the removal of crude protein, crude fat and nitrogen-free extractives. Crude fibre of the cocoyam sample was determined using the standard method for crude fiber determination by the Association of Official

Analytical Chemists (AOAC, 1990) method. The fraction remaining after digestion of foods with standard solutions of suphuric acid and sodium hydroxide (under controlled conditions) is referred to as the crude fibre of the food in question. The loss in weight after incineration x 100 becomes the percentage of crude fibre.

2.7 Determination of Crude Protein

This method involves the digestion of sample with hot concentrated sulphuric acid in the presence of a metallic catalyst. Organic nitrogen in the sample becomes reduced to ammonia. This is retained in the solution as ammonium sulphate. The solution is made alkaline, and then distilled to release the ammonia. The ammonia is trapped in dilute acid and then titrated. In this study, exactly 1g of the dried sample was weighed into a 30ml kjehdal flask. Then 1g of the kjehdal catalyst mixture was added and the mixture was heated cautiously in a digestion rack under fire until a clear solution appeared. The clear solution was then allowed to stand for 30 minutes and allowed to cool. After cooling, about 100ml of distilled water was added to avoid caking and then 50ml transferred to Kjehdal distillation apparatus. A 100ml receiver flask containing 5ml of 2% boric acid and indicator mixture containing 5 drops of Bromocresol blue and 1 drop of methlene blue was placed under a condenser of the distillation apparatus so that the tap is about 20cm inside the solution. The 5ml of 40% sodium hydroxide was added to the digested sample in the apparatus and distillation commenced immediately until 50 drops gets into the receiver flask, after which it was titrated to pink colour using 0.01N hydrochloric acid. The percentage nitrogen and protein were determined using:

$$\% \text{ Nitrogen} = \text{Titre value} \times 0.01 \times 14 \times 4 \quad (2)$$

$$\% \text{ Protein} = \% \text{ Nitrogen} \times 6.25 \quad (3)$$

2.8 Determination of Ash

The ash in biological materials analysis refers to inorganic residue that remains after the organic matter has burnt off. The ash is not usually the same as the inorganic matter present in the original matter since there maybe issues due to the volatilization or chemical interaction between the constituents. The importance of the content is that it gives an idea of amount of mineral elements present and the content of organic matter in the sample. Here, an empty platinum crucible was washed, dried and the weight noted. Exactly 2g of the dried

sample was weighed into the platinum crucible and placed in a muffle furnace at 500^{0}c for 3 hours. The sample was cooled in a desiccator after burning and weighed. The ash content was then calculated using:

$$\% \text{ Ash content} = \frac{\text{weight of ash}}{\text{Weight of original food}} \times 100 \quad (4)$$

$$= \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

Where W_1 = weight of empty platinum crucible, W_2 = weight of platinum crucible + food before drying and /or ashing, and W_3 = weight of crucible and ash.

2.9 Determination of Crude Fat

The free lipid and free fatty acid content of sample can be determined by filtration methods. The solvent was washed off and the extract dried weighed. To 2g of the sample, 100ml of chloroform and 50ml of methanol were added inside a capacity flask and the mixture was left for 24 hours after which it was filtered. The residue was washed again with a mixture of chloroform and methanol and the filtrate was introduced into a separating funnel and water added. The lower chloroform layer was separated into a conical flask and then evaporated to dryness. The percentage fat was determined using:

$$\% \text{ fat} = \frac{\text{weight of oil}}{\text{Weight of sample}} \times 100 \quad (5)$$

Data Analysis

Descriptive and inferential analysis was adopted. The inferential statistical tools used were the completely Randomized Design (CRD). Analysis of variance (ANOVA) is used to test the hypothesis. The test was carried out at 0.05 confidences interval (under appropriate degrees of freedom).

RESULTS AND DISCUSSION

3.1 Proximate Analysis Results of the Treated Cocoyam Sample at 50^{0}C.

The values of nutritional contents of the cocoyam for different pre-treatment sample from three replications, I, II and III are presented in table 3.1, 3.2 and 3.3 respectively.

Table 3.1: The results of the three replicates of the proximate analysis of untreated Cocoyam samples at 50^0C

Replicate	Moisture	Protein	Fat	Ash	Fibre	Carbohydrates
I	44.55	2.60	16.10	3.50	9.08	37.65
II	44.15	3.00	16.50	3.60	9.50	39.65
III	44.35	2.80	16.50	3.40	9.92	38.65
Mean	44.35	2.80	16.50	3.50	9.50	38.65

Table 3.2: The results of the three replicates of the proximate analysis of blanched Cocoyam samples at 50^0C

Replicate	Moisture	Protein	Fat	Ash	Fibre	Carbohydrates
I	41.80	3.25	26.50	2.75	1.25	23.70
II	40.80	3.75	27.50	3.00	1.75	23.50
III	42.80	3.50	27.00	3.25	1.50	23.90
Mean	41.80	3.50	27.00	3.00	1.50	23.70

TABLE 3.3: The results of the three replicates of the proximate analysis of steeped Cocoyam samples at 50^0C

Replicates	Moisture	Protein	Fat	Ash	Fibre	Carbohydrates
I	48.15	5.50	1.25	2.25	8.00	42.00
II	48.00	5.50	1.50	2.75	8.75	43.50
III	48.30	5.70	1.75	2.50	8.75	42.75
Mean	48.15	5.60	1.50	2.50	8.50	42.75

The mean values for different treatments are presented in table 3.4 below.

Table 3.4: Summary of the proximate values of the three sample treatments of the cocoyam slices at 50^0C

Sample	Moisture	Protein	Fat	Ash	Fibre	Carbohydrates
Untreated	44.35	2.80	16.50	3.50	9.50	38.65
Blanching	41.80	3.50	27.00	3.00	1.50	23.70
Steeping	48.15	5.60	1.50	2.50	8.50	42.75
Total	134.30	11.90	45.00	9.00	19.50	105.10
Mean	44.77	3.97	15.00	3.00	6.50	35.03

The analysis of variance (ANOVA) of the nutritional content values are presented in table 3.5 below.

Table 3.5: Analysis of variance (ANOVA) table for the treatment means of the cocoyam samples at 50^0C

Sources of Variation	df	Sum of Squares (SS)	Mean square (MS)	Fcal	Ftab
Treatment	2	4709.28	2354.64		5.14
Error	6	592.74	98.79	23.83	
Total	8	5302.02			

3.2 Proximate Analysis Results of the Treated Cocoyam Sample at 70^0c

The values of nutritional contents of the cocoyam for different pre-treatment sample from three replications, I, II and III are presented in table 3.6, 3.7 and 3.8 respective

Table 3.6: The results of the three replicates of the proximate analysis of untreated Cocoyam samples at 70^0C

Replicates	Moisture	Protein	Fat	Ash	Fibre	Carbohydrates
I	38.00	3.25	6.75	1.98	6.20	43.00
II	38.50	3.75	7.00	2.04	5.90	43.25
III	38.25	3.50	7.25	1.98	5.90	43.50
Mean	38.25	3.50	7.00	2.00	6.00	43.00

Table 3.7: The results of the three replicates of the proximate analysis of blanched Cocoyam samples at 70^0C

Replicates	Moisture	Protein	Fat	Ash	Fibre	Carbohydrates

I	36.50	2.70	6.25	2.25	2.35	26.35
II	37.00	2.80	6.50	2.75	2.55	26.45
II	36.75	2.90	6.75	2.50	2.60	26.55
Mean	36.75	2.80	6.50	2.50	2.50	26.45

TABLE 3.8: The results of the three replicates of the proximate analysis of steeped Cocoyam samples at 70^0C

Replicates	**Moisture**	**Protein**	**Fat**	**Ash**	**Fibre**	**Carbohydrates**
I	39.00	2.00	8.50	4.40	5.90	30.00
II	39.30	2.20	8.00	4.50	6.00	30.40
III	39.15	2.10	8.10	4.60	6.10	30.20
Mean	39.15	2.10	8.50	4.50	6.00	30.20

The mean value for different treatments are presented in Table 3.9 below.

Table 3.9: Average Proximate values of Cocoyam samples for the three treatments at 70^0C

Sample	**Moisture**	**Protein**	**Fat**	**Ash**	**Fibre**	**Carbohydrates**
Untreated	38.25	3.50	7.00	2.00	6.00	43.25
Blanching	36.75	2.80	6.50	2.50	2.50	26.45

Steeping	39.15	2.10	8.50	4.50	6.00	30.20
Total	114.15	8.40	22.00	9.00	14.50	99.90
Mean	38.05	2.80	7.33	3.00	4.83	33.30

The analysis of variance (ANOVA) of the nutritional content values are presented in table 3.10 below.

Table 3.10: Analysis of Variance (ANOVA) table for the cocoyam treatment means at 70^0C

Sources of Variation	**df**	**Sum of Squares (SS)**	**Mean square (MS)**	**Fcal**	**Ftab**
Treatment	2	4124.61	2062.30	1036.33	
Error	6	11.95	1.99		5.14
Total	8	4136.56			

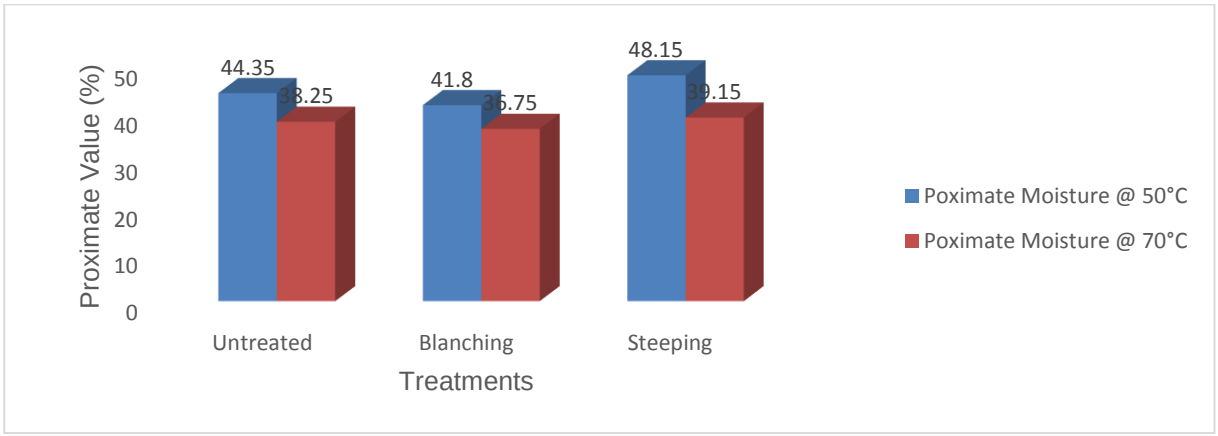

Fig. 3.1: Comparism of the Mean Moisture Proximate Values @ 50°C and 70°C

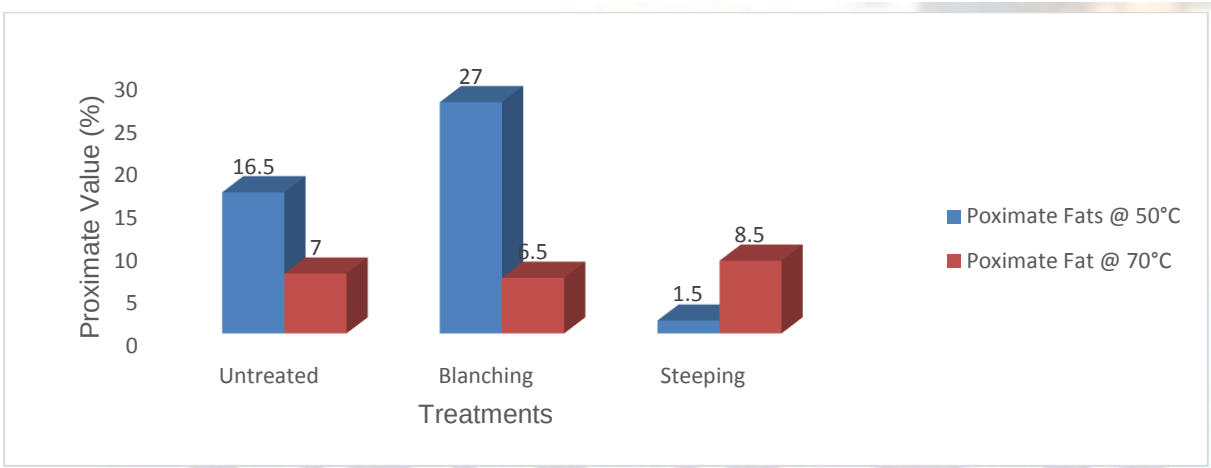

Fig. 3.2: Comparism of the Mean Fat Proximate Values @ 50°C and 70°C

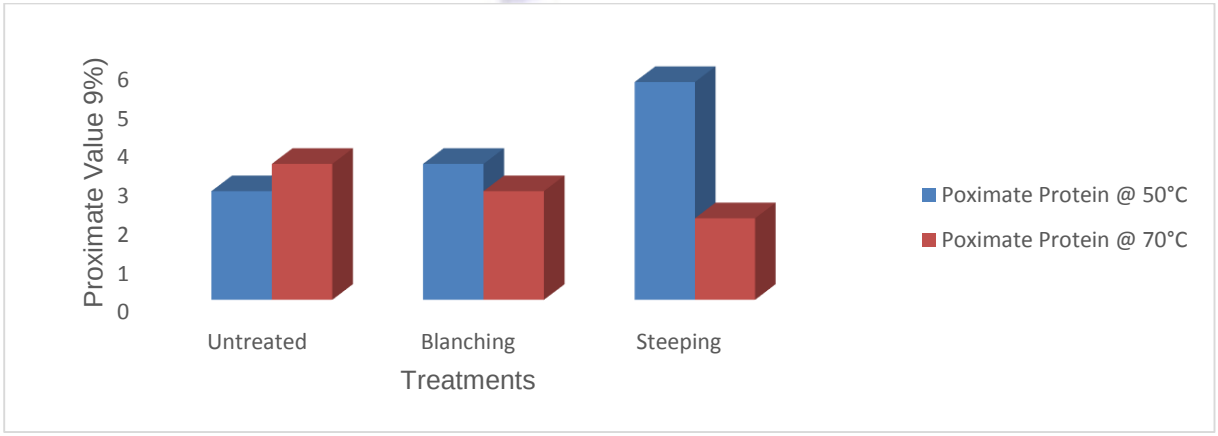

Fig. 3.3: Comparism of the Mean Protein Proximate Values @ 50°C and 70°C

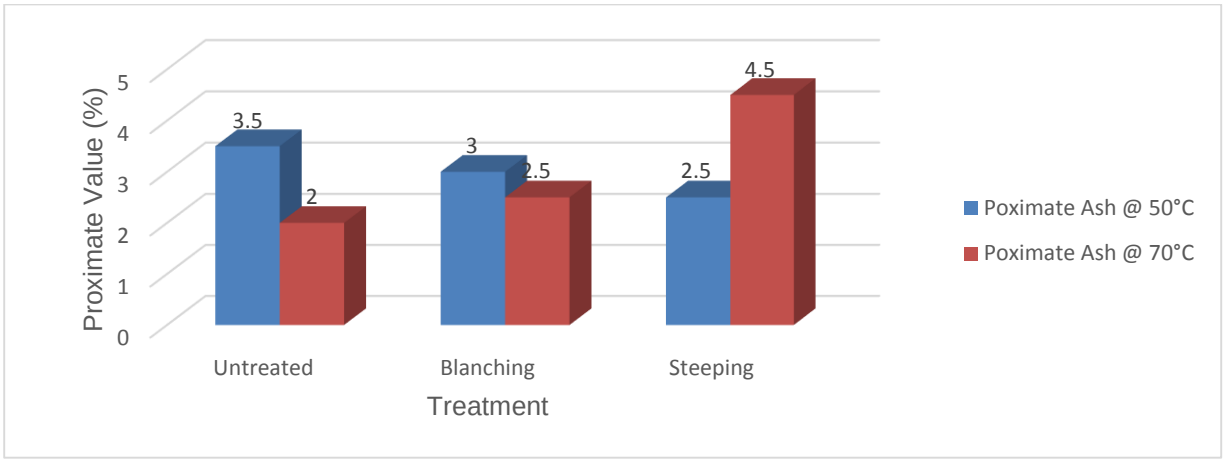

Fig. 3.4: Comparison of the Mean Ash Proximate Values @ 50°C and 70°C

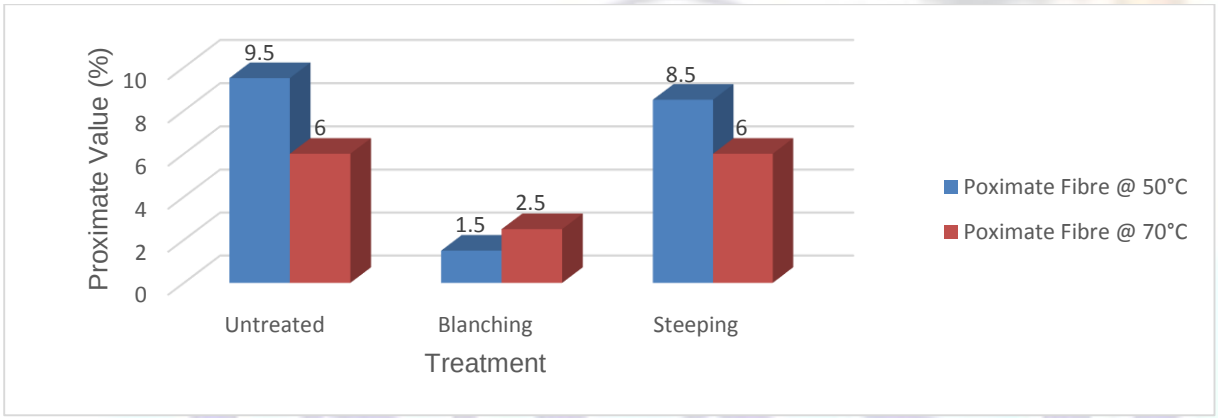

Fig. 3.5: Comparison of the Mean Fibre Proximate Values @ 50°C and 70°C

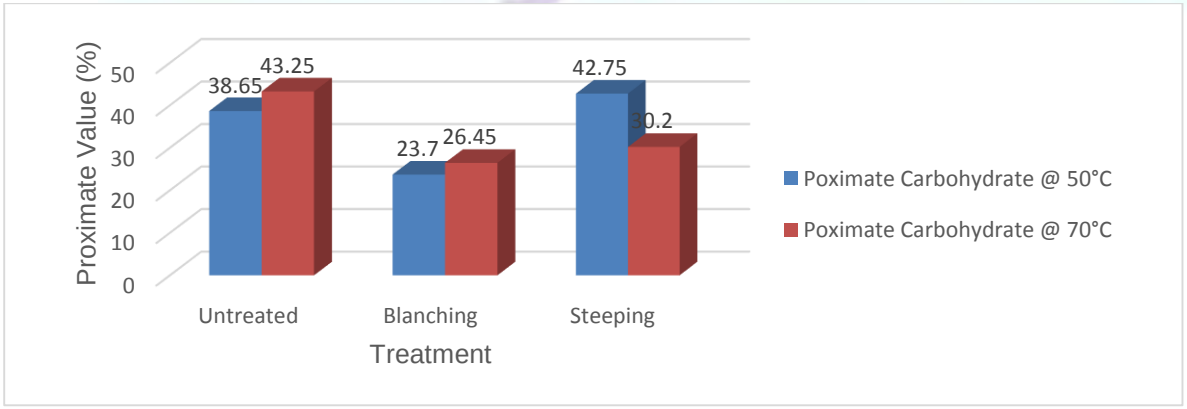

Fig. 3.5: Comparison of the Mean Carbohydrate Proximate Values @ 50°C and 70°C

The results of moisture, protein, ash, crude fat, crude fire and carbohydrates of cocoyam slices which were produced using oven drying method in their percentage composition are shown in Tables 3.1 to 3.10 respectively. Fig. 3.1 to 3.6 presented the comparism features of the proximate contents of samples at the two levels of temperatures (50°C and 70°C) in view. There was a huge difference between the steeped sample dried at 50^0C and the steeped sample dried at 70^0C.

The protein content ranged between 2.1 – 5.6% and it was found to be highest in the cocoyam sample that was steeped and being dried at 50^0C while the steeped sample that was dried at 70^0C had the lowest value. The fat content ranged between 1.5 and 27% with the dried blanched sample dried at 50^0C having the higher value; while the steeped dried sample at 50^0C also had the lowest value. The ash content which is the total mineral content present in the samples ranged between 2 and 4.5% with the steeped dried sample at 70^0C having the highest value and untreated dried at 70^0C sample having the lowest value. The crude fibre content which is the organic residue present in the sample ranged between 1.5 to 9.5% with the (control) sample dried at 50^0C having the highest value of 9.5%; while the blanched sample dried at 50^0C also had lowest value of 1.5%. The carbohydrate content ranged between 23.7% and 43.25%, with the untreated (control) sample dried at 70^0C having the highest value of 43.25% and the blanched sample dried at 50^0C having the lowest value of 23.7%.

CONCLUSION

Cocoyam slices samples with three pre-treatments using two different temperatures of 50^0C and 70^0C respectively measuring $\pm$ 3.5cm each was oven dried to determine the effect of pre-treatment on the quality of cocoyam slices. The results of the experiments carried out (on the cocoyam chip) indicated that pre-treatment methods at 50^0C and 70^0C temperature affect proximate composition of the chip by not only altering the biochemical composition but also the functional properties. There was appreciable difference in the nutritional content of the cocoyam slice due to the difference in temperature and treatment applied with the following ANOVA results for of samples dried at 50^0C = 23.83 (Fcal) and 1036.33 (Fcal) at 70^0C. Similarly, ash content of the cocoyam dried at 50^0C was the same as in the cocoyam dried at 70^0C. The result of this study shows that low temperature drying is a good nutritional conservation measure as it tends to reduce the nutritional loss to a minimum bearable level. The blanched dried sample at 50^0C gave more desirable result for fat result while the untreated dried sample at 50^0C gave better crude fibre result.

Since the ultimate objective of this research was to solve nutritional degradation problem by determining suitable pre-treatment method for adequate food quality preservation, it is therefore recommended that further work be done using different pre-treatment methods to determine the best nutritional conservative method.

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