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Impact of Autoclaving Pressure on the Proximate Composition of White Yam (*Dioscorea rotundata*) in Yola, Adamawa State

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Abstract
The study determined the effect of heating pressures using autoclave on the proximate composition of white yam with a view of adopting Short Time High Temperature (STHT) heat treatment technology for its processing, preservation and storage. The study was conducted in 2015 to evaluate the impact of varying autoclaving pressure on proximate composition of white yam (Dioscorea rotundata) in Yola . Treatments consisted of yam (*D. rotunda*) processed and divided into five representative samples with five autoclaving pressures (0Kpa, 100Kpa, 150Kpa, 200Kpa and 250Kpa). Treatments were then laid out in a Completely Randomized Design (CRD) and replicated three times. Autoclaved white yam produced a product with reduced crude protein, ether extract, fibre, ash and carbohydrates content. This method of processing of white yam also resulted in product with increased dry matter content and the optimum pressure for autoclaving white yam without adverse reduction in nutrient content is 100 – 150Kpa. It is therefore, suggested that Short Time High Temperature (STHT) heat treatment technologies could be adopted for white yam processing, preservation and storage.

Keywords: White, Yam, Parboiling, Proximate, Content

Introduction

Yam (*Dioscorea* spp) is one of the major food crops in West Africa, the Caribbean, and Islands of the South Pacific, South East Asia, India and part of Brazil (Ahmed *et al*., 2018; Wickham, 2019). Nigeria alone account for more than half of the world's total production (UNESCO, 2010). Great technical advances were made in the physical methods of processing and preservation of food crops over the last century, but these methods are not satisfactory for all types of food due to organoleptic and nutritional changes that occur in the process of applying these methods thereby limiting their adoption without evaluating the adverse effects caused (Swetman, *et al*., 2002).

Postharvest processing of food crops such as milling and drying however, may also result in losses in both overall quality, nutritional value and shelf-life of the final product (Swetman *et al*., 2002). Proper processing can preserve or save destruction of nutritional content of yam; hence the need to pay special attention to the processing of yam in order not to destroy its nutrients and render the product unwholesome. Yam postharvest treatments should therefore be performed carefully and gently.

Yam tubers are stored between harvests for 4-5 months after which losses occur since there is little industrial processing. Losses occur at various stages of the production, postharvest handling, marketing and consumption of yam; these losses are both qualitative and quantitative. Factors such as abiotic, biotic and physiological are responsible for these losses. National Academy of Sciences [NAS] (2005), reported an estimated total losses of roots and tubers are in the range of 5% to 60%. Up till today the age old traditional methods of processing yam into chips and flour are employed. The quality of the yam chips and flour varies from processor to processor and from location to location (Akissoe *et al.*, 2001; Hounghouigan. *et al.*, 2003; Mestres *et al.*, 2004).

The rate of growth in food production in Nigeria is very low totaling to 2.5% per annum which is attributable to poor preservation (Odigbo, 1991).The low level of preservation had led to poor management of agricultural produce in the country (Aasa *et al*., 2012). Her poor preservation may be due to lack of steady power supply, low postharvest technologies and the high capital requirements for the purchase of refrigerating facilities. According to Opara (1999), the present methods of yam processing causes nutrient losses in yam products. Such losses can be high, particularly in minerals and vitamins. Likewise also, primary operations such as Sun drying, milling and pounding using wooden mortar causes loss of thiamine and riboflavin contents of *D. rotundata*, with average losses of 22% and 37%, respectively (Bencin, 1991).

Yam processing can therefore cause a very significant effect on the nutritional quality of products hence the need for this work, which is to evaluate the impact of heat treatment on the proximate composition by varying the autoclaving pressure for possible adoption in the processing and preservation of yam.

Materials and Methods

The experiment was conducted at Yola (latitude 9^0 23'N of the equator and longitude 12^0 46'E of the Greenwich meridian), Adamawa State in 2015. The area is marked by two distinct seasons namely; wet (June - October) and dry (November - May) seasons. The maximum temperature of the areas can reach 40^0 C in April and a minimum 18^0 C between December and January; the mean annual rainfall usually ranges from 700 mm to 1050 mm (Adebayo, 1999). The vegetation of the areas is basically Northern Guinea Savannah (Akosim *et al*., 1999).

Treatments consist of white yam (*D. rotunda*) and five autoclaving pressures (0Kpa, 100Kpa, 150Kpa, 200Kpa and 250Kpa) as recommended autoclaving pressure for proper sterilisation by World Health Organisation [WHO] (2016). The experiment was laid in a Completely Randomized Design (CRD) and was replicated three times. All treatments contain 100 grams of white yam.

Well matured fresh yam tuber of appropriate size was washed cleaned, peeled, and sliced into chunks of average thickness of 10mm, square shape and size of 15mm x 15mm as described by Falade *et al.* (2007) and soaked overnight. The yam slices were divided into two portions. One portion was blanched (control) while the other portion was blanched and autoclaved at different pressures. Data were collected on the proximate composition of the sample employing standard laboratory proximate analysis procedures according to Association of Official Analytical Chemists [AOAC] (2005) using following formulae:

Percentage Ash Contents

$$\%\, Ash\ (dry\ basis) = \frac{Weight\ of\ ash}{weight\ of\ original\ sample} \times 100$$

Percentage Ether extracts (Fat)

$$\%\, fat = \frac{weight\ of\ fat}{weight\ of\ sample} \times 100$$

Percentage Moisture Content

$$\%\, moisture = \frac{loss\ of\ weight}{weight\ of\ sample\ before\ drying} \times 100$$

Percentage Carbohydrate Content

$$(\%)\ Available\ carbohydrate = 100 - (\%\, moisture + \%\ ash + \%\ fat + \%\ fibre + \%\, protein)$$

Percentage crude protein Content

$$Crude\ protein = \%\, nitrogen \times 6.25\ (conversion\ factor)$$

Percentage Dry Matter Content

$$\%\, Dry\ matter = 100\% - Moisture\ content$$

Percentage Crude fibre content

$$\%\ crude\ fibre = \frac{weight\ of\ sample\ used - weight\ of\ sample\ crucible}{weight\ of\ sample\ used} \times 100$$

Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA) using [SAS] (1999). Least Significant Differences (LSD) tests were used to compare means that shows significant difference.

Results and Discussion

There was highly significant (P ≤ 0.01) reduction in crude protein content as a result of varying autoclaving pressure (Table 1), which depreciated within the range of 0.47 to 3.03% for pressures of 100-250KPa. White yam autoclaved at 250Kpa had the highest decrease in crude protein content. The reduction manifested in this trial could be due to progressive denaturing, dissolution of water soluble amino acids and leaching out of nitrogenous compounds. This decrease in crude protein content is in total agreement with the findings of Udensi *et al* (2010) who reported decrease in protein content of *Mucuna flagellipes* after soaking, boiling and autoclaving.

Table 1: Effect of Autoclaving Time on the Proximate Composition of Yam

Treatment	Protein	Ether Extract	Fibre	Ash	Moisture	Dry matter	Carbohydrates
0Kpa	6.23^{a}	1.40^{a}	1.68^{a}	3.68^{a}	26.30^{a}	85.93^{a}	75.28^{a}
100Kpa	5.76^{b}	0.76^{b}	1.66^{b}	3.22^{b}	16.13^{b}	85.77^{b}	74.56^{b}
150Kpa	5.7^{c}	0.72^{c}	1.11^{b}	2.75^{c}	15.43^{c}	84.57^{c}	73.62^{c}
200Kpa	5.40^{d}	0.68^{d}	0.85^{b}	2.74^{d}	14.53^{d}	83.27^{d}	73.32^{d}
250Kpa	3.20^{e}	0.52^{e}	0.72^{d}	2.49^{e}	14.23^{e}	73.70^{e}	65.30^{e}
LSD	0.12	0.06	0.31	0.12	0.02	0.02	0.53
Level of significance	**	**	**	**	**	**	**

Figures with the same superscripts within a column are not significantly different from each other. **= Highly Significant at 1% of level of Significance. LSD= Least Significant Difference,

Ether extract or fat content had a highly significant decrease (p ≤ 0.01) when subjected to different autoclaving pressure (Table 1). The fat content decreased by 0.64 to 0.88% with highest decrease recorded from sample subjected to 250Kpa.This development could be attributable to oxidation and evaporation of volatile oils. The result of this study is in line with earlier workers (Nsa *et al*., 2011; Ezeocha and Ojimelukwe (2012) and Augustine, 2017) who claimed reduction in ether extract content of castor, water yam and sickle pod seeds respectively.

There was a highly significant (P ≤ 0.01) effect of varying autoclaving pressure (Table 1) on the crude fibre content of white yam. Highest effect was recorded on white yam pressurised to 250 Kpa. The progressive reduction in crude fibre content noticed due to pressure increase could be linked to leaching out of water soluble part of the crude fibre as stated earlier by Udensi *et al.*, (2010), Augustine (2017) and Augustine *et al.*, (2017) who subjected different produces to varying boiling periods.

Table 1 showed that, highly significant (P ≤ 0.01) differences were revealed between the control and autoclaved white yam at different pressure. Increasing pressure of autoclaving led to decline in the ash content, where the highest decline observed on sample autoclaved for 250Kpa. This might be as a result of dissolution and leaching out of water soluble minerals which constitute the bulk of the ash content. This finding is in tandem with Augustine (2017) and Ezeocha and Ojimelukwe (2012) who observed that ash content of sickle pod seed and water yam decreases with increased boiling.

The moisture content of white yam autoclaved at varying pressure displayed highly significant ($P \leq 0.01$) loss in moisture content. The moisture content decreases as pressure increases (Table 1) and sample subjected to 250Kpa posted the highest loss. This trend could be ascribed to evaporation of water during autoclaving and this position is buttressed by Ezeocha and Ojimelukwe (2012) who reported reduction in moisture content of water yam after at cooking at varying periods.

White yam autoclaved at different pressure showed highly significant ($P \leq 0.01$) effect in terms of dry matter content as depicted in Table 1. There was decrease in dry matter content due to increasing pressure of autoclaving, with yam pressurized at 250Kpa leading the losers. This result is in agreement with earlier assertions by previous workers (Udensi *et al*., 2010; Augustine, 2017; Augustine *et al*., 2017) who reported decline in dry matter content of some produce. The decrease could be due loss of moisture through the process of evaporation and leaching out of water soluble nutrients.

Carbohydrate content was highly ($P \leq 0.01$) impacted by pressure variation during autoclaving, Table 1 revealed a decrease in carbohydrate as pressure increases and sample treated with 250Kpa had the highest decrease which could be explained by leaching out of water soluble starch caused by heat and steam. Similar results were reported by Azam-Ali (2003), Ezeocha and Ojimelukwe (2012) and Augustine *et al* (2017).

Conclusion

Variation in pressure during autoclaving yielded product with reduced protein, ether extract, fibre, ash, moisture, dry matter and carbohydrates contents. The optimum pressure for autoclaving white yam without much adverse reduction in nutritional quality is 100-150Kpa. It is therefore, suggested that high pressure heat treatment technologies such as canning and aseptic packaging could be adopted for white yam processing to produce product with high nutrient content. This product could be preserved and stored under ambient condition for long time thus ideal for developing countries that are facing power challenges.

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