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Effect of Blanching and Oven Drying on the Sensory Quality of Stored Fresh Maize

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Abstract: **Fresh maize, harvested at the milk stage, was treated by blanching in order to maintain the sensory quality of the samples at the milk stage. The samples were blanched, dried and then stored. The samples were blanched at different time interval ranging from 5 minutes to 30 minutes respectively.**

Sensory evaluation was then carried out on the blanched, dried and stored samples after re-cooking for palatability, colour, taste, texture, general acceptability etc.

Maize samples blanched for 15 minutes and 20 minutes were adjudged by panellists to be of better quality. At these blanching times range (15 and 20 minutes), it was observed that the rates of reduction of soluble sugars in the samples were lesser when compared with those of other treated samples and the control (unblanched) samples.

The treated and stored samples after re-cooking gave a taste similar to that of fresh produce as observed in the experiment.

Keywords: **Blanching, Drying, Fresh Maize, Milk Stage, Sensory Quality, Soluble Sugars.**

1. INTRODUCTION

Fresh maize (*Zea mays*), most especially sweet maize, is a kind of perishable vegetables with high respiration rate and sweetness lost is the main quality degradation during storage. A well balanced diet for the growing populace is of great importance for the future of mankind. The word *maize* was derives from the Spanish form of the indigenous Taino word for the plant, *maiz* [6], but known by other names around the world. Maize is the domesticated variant of *teosinte [*7]. It is believed that maize came to being around 2500BC and spread through much of the Americas [2]. Maize spread to the rest of the world because of its ability to grow in diverse climates. Maize is the most widely grown crop throughout the Americas [3], with 332 million metric tons grown annually in the Unites States alone. Approximately 40% of the crop -130 million tons- is used for corn ethanol [4]. Genetically modified maize made up 85% of the maize planted in the United States in 2009 [5], [9]. Maize is widely cultivated throughout the world, and a weight of maize is produced each year than any other year [8].

The cereal grains that form most of the diet of developing countries include maize, sorghum, millet, rice, barley, wheat etc. These grains contain low protein. Lysine is the most limited essential proteins in cereal [10], [11]. The position of maize in diet and its potential role at increasing productivity in agriculture makes it of special interest in the study of tropical countries. Its study is very important because of its ability to withstand extremes of climate.

In the Southern part of Nigeria, about 89-91% of the total cereal grains consumed is maize [12]. The maize grown and harvested fresh is of high moisture content and consumed in Nigeria either boiled or roasted. They may be dried and stored for future use such as milling or fermenting or a combination of the above. They may also be wet milled and made into ogi which can be used as a weaning food for infants or a major breakfast for adults or other sects of the populace [13].

Various postharvest techniques have been adopted in advanced countries of the world to preserve and maintain the quality of fresh maize (most times sweet maize) and other commodities such as fruits, vegetables, seafood, tubers etc. They have been preserved with modified atmosphere [27], [33], shrink-wrapping [19], perforated package [32] and combination of shrink-wrapping, refrigeration and irradiation [22].

Controlled freezing is a preservative method that had been applied in stored seafood [20], [38], [26], animal organ [28]- [29] and has equally been applied in the storage of fresh fruits, vegetables, sweet corn [30], [25] in order to reduce or maintain low respiration rate of sugar reduction after harvest. Report has it that about 60 and 6% of the sugar was lost in a single day at 30 and 0^{o}C, respectively [21], while the effect at temperature above 0^{o}C was studied [35], [31]. It is noticed that if freshly harvested maize at the milk stage with high moisture content is left for hours without being consumed either by cooking or roasting, a loss in the sweet taste and juicy flavour associated with freshly harvested maize on cob would be observed when eventually cooked because most of the total sugars responsible for the sweet taste would have been metabolized i.e. used for respiration. Enzymes in the maize quickly convert the natural sugars to starch, which takes away the wonderful fresh sweet maize taste. The loss in the taste of freshly harvested maize on cob has been of great concern to the teeming consumers of this seasonal produce.

A way should be devised such that freshly harvested maize could be stored for sometimes with most of nutrients present retained. In advance countries of the world like in the United States of America, freshly harvested maize with very high moisture content are either canned or kept frozen in the deep freezer which results in maintenance of the sweet taste over a long storage period [34], [24]. The purpose of this work is to extend the shelf life of the fresh maize at the milk stage by reducing its respiratory metabolism i.e. reduce considerably or stop maize from respiring which causes the depletion of the sugars present in the maize.

In most developing countries of the world, most of those involved in the farming are low income people who live mostly in rural or remote areas of the countries. Their poor purchasing power cannot avail them the opportunity of venturing into acquiring sophisticated equipment for preservation or extending the shelf life of these produce. They record very high quantity of wastages and as a result, could not meet the need of numerous consumers [36]. Freshly harvested maize grains with high moisture content are mostly preserved by sun drying in most developing countries (they dry in order to reduce moisture because most disease-causing organisms require a moist environment in which to survive and multiply), while in most developed countries, these abundant produce are stored in deep freezers. This preservative method are above the reach of these rural farmers in less advanced countries, especially in the tropics where cost of purchasing the deep freezers is very high and electricity bill is also an added cost.

Based on all these shortcomings/limitations, a suitable, simple and affordable technology is to be devised in preserving the sweet taste of the fresh maize at the milk stage. Blanching of the fresh maize in boiling water before drying and storage could help retain the sweetness for a longer period.

Blanching is a form of heat treatment of pasteurization mostly applied to fruits and vegetables to inactivate natural food enzymes. Blanching is normally carried out on produce to be frozen etc. Blanching can be at a temperature below that of the boiling water temperature or at the temperature of boiling water. Although blanching is not used extensively in commercial preservation of fruits because of its effect on the changes in composition during blanching of fruits [18].

Blanching used as a preservative method has various functions such as:

(a) To remove foreign materials including plant juice which may influence flavour.

(b) To expel air and other gases which might create excessive pressure in the sealed container.

(c) To produce the desired appearance of the finished product by fixing colour to the material.

(d) To inactivate enzymes which might result in breakdown of food materials and.

(e) To decrease bacterial load by acting as a hot dip wash.

For this works, the main objective is to devise a simple technology affordable to poor rural farmer in which the shelf life of fresh maize at the milk stage could be extended. This is to be accomplished by:

(i) Inhibiting respiration in the fresh maize. Respiration uses the sugar for its metabolism and

(ii) Devising a simple technology to extend the shelf life of the fresh maize by reducing the moisture content of the fresh samples.

2. Materials and Method

Maize Sample: Blend of white and yellow maize was used for this experiment. They were planted at a farm at Ajibode Village, University of Ibadan on the 20th of March, 2014.

Preliminary Experiment: The maize cobs were harvested between 23rd May, 2014 and 6th June, 2014 with daily analysis carried out on the harvested samples to monitor the rate of degradation of total sugar in the fresh maize with age. The maize cobs were harvested when they were still at the milk stage. It is worth noting that from literature, maize is usually physiologically mature about 7 to 8 weeks after flowering, at that time the kernel contains 35-40 percent of moisture and has the maximum content of dry matter, which also depend on variety [37].

This maturity period varies based on the fact that the period from planting to harvesting varies considerably and mostly influenced by climate.

Sample Preparation: Samples used for the analysis were normally harvested very early in the morning before 7.00am and kept in cold water at very low temperature for rapid cooling of the harvested samples and also to reduce drastically the rate of respiration in which the sugar present is being made use of. This was then transported to the laboratory.

Treatment: The transported maize cobs have some of the sheaths removed before processing as follows:

Blanching

↓

(In boiling water at various time intervals)

Drying

↓

(In the oven at 50 $\pm$ 2^{0}C instead of sun drying)

Analysis

The water was made to boil and samples dipped into the boiling water. Samples were blanched at 5 minutes intervals between 5 to 30 minutes. The blanched samples were cooled very fast before oven dried. The temperature of the oven was adjusted to 50 $\pm$ 2^{0}C and the samples kept in the oven for few hours before analysis. Reference samples were not blanched or oven dried. The samples were blanched to stop the respiratory activities of the samples and also stop enzymatic activities taking place in living freshly harvested maize samples. The blanching was to destroy the sugar converting enzymes.

Total Sugar: Extraction and Determination: The extraction of sugars from the crushed or milled samples was done according to the method of analysis by [14]. The method is as follows:

About one gramme of the sample was weighed and was extracted with 50mls of hot ethanol. It was then centrifuged for 10 minutes at 200rpm. The supernatant

was decanted into a test tube (this is the sugar while the residue is the starch). The supernatant was made up to 20mls with water. 0.8mls of distilled water was added to an aliquot of the extract in which 0.5mls of 5% phenol was again added and vortexed.

2.5 mls of concentrated hydrogen tetra-oxosulphate (vi) acid was added and then vortexed. It was then cooled and read at an absorbance of 490nm wavelength in a spectrophotometer. Using a prepared standard curve to estimate the concentration of total sugar in the sample could be calculated from the equation:

$$\frac{1/slope \times Abs \times 100}{Weight\ of\ sample \times 10{,}000}$$

Abs = Absorbance at 490nm

Sensory Evaluation of Treated Samples: Samples were blanched at different time intervals ranging from 5 minutes to 30 minutes. The blanched samples were dried to low moisture content (between 16 and 17%), stored for a certain period of time and re-cooked again. The quality of the re-cooked treated samples was evaluated by a 20 member panel composed of people familiar with the sensory quality of fresh maize. The colour, taste, texture, flavour and overall acceptability were rated on a scale ranging from 9 = liked extremely to 1 = disliked extremely. The scores from the hedonic scale were averaged to obtain the mean scores which were subjected to analysis of variance.

Statistical Analysis: Statistical analyses of all data were done with Statistical Analysis System (SAS) package (15). All analyses were carried out in three replicates and duplicates. Statistically significant differences ($P<0.05$) in all the data were determined by analysis of variance (ANOVA).

3. Results and Discussion

Changes of Sugar Contents in Fresh Maize with Age: The sugar content in fresh maize is presented in Table 1. It was observed that total sugar content in fresh maize increases gradually initially to certain level of the milk stage before falling again. Nutritionally, fresh maize is most desired when it is in the milk stage and this milkiness is being caused by the presence of starches and soluble sugars in the liquid. The fall in the total sugar content of the maize may be that the sugar is being used for respiration or according to [16], it was said that as sweet maize matures, sugars may be converted to starch or respired away to carbon dioxide and water.

The total sugar initially increases from 123g/ml in the first week of analysis to 147g/ml in the second week and to 159g/ml in the third week and then falls drastically to 101g/ml in the fourth week and 47g/ml and 12g/ml respectively in subsequent weeks. It is a sign that natural enzymes in the maize are converting natural sugars to starch, which take away the wonderful fresh maize taste.

Table 1: Rate of Degradation with Age of Total Sugar in Fresh Maize after Flowering

Weeks after Flowering	Total Sugar Content (g/ml)
1st Week	123
2nd Week	147
3rd Week	159
4th Week	101
5th Week	47
6th Week	12

Values are an average of 3 Samples

Treatment Effect on Samples: Samples of fresh maize at the milk stage were harvested and treated by blanching in boiling water. The blanched samples were dried to reduce drastically their moisture contents and then stored. Analysis of the sugar in the stored samples started the third day after storage and ends on the seventh day after storage. The result of the effect of treatment on the samples is as presented in Table 2. From the results, it was observed that there were gradual decrease in the total sugar content of all the samples blanched at different time interval with the reference sample inclusive (R). All the samples except the reference sample (R) were blanched at various time intervals (five minutes to thirty minutes) and oven dried before storage under the same condition of temperature (ambient condition) and relative humidity with the reference before analysis. It reported by [23] that sugar content of sweet maize stored under controlled freezing slightly decrease after 5 days of storage; then, a slight increase was observed until day 15 and finally, a sharp fall was detected by day 20 and day 25.

Invariably, it was observed in the blanched, dried, stored samples which was re-cooked for consumption, that the cooked samples gave a taste, similar to that of freshly harvested maize. Although, there were some losses in the process of blanching, drying, storage and re-cooking, but the overall quality or attributes were still very much acceptable. It was equally observed from the table that loss of sugar was more rapid in the unblanched sampled (reference) due to the fact that the unblanched samples do carry out respiration using the sugars present within it. Fresh maize equally habour active natural enzymes which convert sugars to starch, while blanching technique had partially or completely reduced sugar metabolism in the treated samples.

In the report of [23] on sweet corn, it was reported that the respiration rate of sweet corn stored at -1^0C was about 1/3 that of 4^0C during the period of storage. The sugar content of sweet corn was less than that of fresh samples on day 20, at -1^0C and on day 10, at 4^0C during storage. A decline during the period of storage was measured (from 71 mg/g on day 0 to 54 mg/g and 24 mg/g on day 25 at -1 and 4^0C, respectively). This was adduced to the effect of control freezing storage. The cost of this equipment is beyond the capability of rural farmers that engage in farming firstly for sustenance and then to make little income for their immediate family.

Table 2: Effect of Blanching and Drying on Total Sugar Content (g/ml) in Maize

Days of Analysis	Blanching Time in Minutes						
	R(0)	A(5)	B(10)	C(15)	D(20)	E(25)	F(30)
3rd	62	60	65	68	69	70	78
4th	54	58	60	66	61	65	68
5th	48	57	57	64	58	62	67
6th	47	55	55	64	56	60	64
7th	42	54	54	62	55	57	62

All samples measured in g/ml

*Initial moisture content = from over 60% to between 35 and 40% (Average of 4 Samples Before Treatment)

*Final moisture content = Between 16 and 17% (Average of 4 sample before total determination)

*R(0) - Unblanched samples

*A(5) - Blanched for 5 minutes

*B(10) - Blanched for 10 minutes

*C(15) - Blanched for 15 minutes

*D(20) - Blanched for 20 minutes

*E(25) - Blanched for 25 minutes

*F(30) - Blanched for 30 minutes

Sensory Evaluation of the Samples: The results of the sensory evaluation of treated and untreated maize samples are presented in Table 3. Maize samples that had been blanched, dried, stored and re-cooked with the reference samples were then evaluated based on the following characteristics; flavour, colour, texture, taste and general acceptability. From the sensory evaluation of the results, there were no significant differences in the taste and texture of the samples. On the overall acceptability of the samples, the panellists prefer sample (C) that was blanched for fifteen minutes and followed by sample (D) that was blanched for twenty minutes. The preference was based on the final statistical analysis from which sample (C) that was blanched for fifteen minutes was rated highest of all the samples in all the quality attributes except for colour. The colour of the reference samples was better preferred. The colour given by each treated samples was far less than the required quality.

Based on the result of the statistical analysis in which sample (C) blanched for fifteen minutes was generally accepted to be of the highest quality of all the samples (both treated and untreated), this treatment regime could be carried out on a large scale for the extension of the shelf life of the maize sample.

Table 3: Sensory Evaluation of Samples

Maize Samples	Colour	Flavour	Taste	Texture	General Acceptability
R	7.9a	3.0d	4.4a	4.5a	3.5d
A	3.0d	3.9b	4.7a	4.6a	4.3c
B	4.8c	3.9b	4.1a	3.8a	4.3c
C	7.0b	6.1a	5.1a	6.0a	7.6a
D	6.9b	5.4a	5.3a	5.9a	6.3b
E	6.9b	5.9a	5.2a	5.9a	6.3b
F	3.0d	3.5c	4.6a	4.6a	3.5d

*Means followed by the same letter are not significantly different at 5% level of Tukey

*Mean +SD down a column with superscript are significantly different with a>b>c>d.

*R – Unblanched Sample

*A – Sample blanched for 5 minutes

*B – Sample blanched for 10 minutes

*C – Sample blanched for 15 minutes

*D – Sample blanched for 20 minutes

*E – Sample blanched for 25 minutes

*F – Sample blanched for 10 minutes

The result showed that the taste and general acceptability in particular of the treated samples were close to that of fresh maize and better than samples without treatment. Blanching of maize samples are expected to inactivate enzymes in the plant [17]. This may have been the cause of the soluble sugar retention in the sampled maize cobs.

4. CONCLUSION

From the experiment results, it was observed that blanching of fresh maize at the milk stage preserve the taste better than leaving it under ambient condition. Fresh maize samples harvested at the milk stage and blanched in boiling water for certain time interval and dried in the oven at temperature of about 50 $\pm$ 2^0C for sometimes to reduce the moisture content before storage. The result obtained after rehydrating the stored sampled and comparing the taste with that of fresh sample shows that the taste is slightly similar to that of fresh sample after some days precisely about a week but it was observed that as days rose by it, the taste of the treated samples reduces or deteriorates.

The study also indicates that loss of soluble sugars from fresh maize is the major factor that results in staleness of fresh maize. It also seems that blanching at the right

temperature controls rapid loss of soluble sugars and also aids the development of an attractive colour in yellow maize. The sensory panellist rated the samples blanched for 15 and 20 minutes respectively better than other treated samples in comparable to that of the fresh samples.

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Currently, he is the Principal Administrative Secretary of the University of Ibadan Alumni Association, UIAA.

Dr. Dauda has attended some workshops, Conferences and trainings within the shores of his country, Nigeria. He currently has about five (5) journal publications and a Chapter of a book to his credit. He is on the verge of joining a research institute or a tertiary institution in Nigeria by virtue of his completion of his doctorate programme.

Dr. Dauda is happily married to Mrs. Olubunmi M. Dauda and the wedding is blessed with three (3) lovely kids.