Cyperus esculentus: Moisture Absorption Behaviour, Extract Yields and Sensory Evaluation of Soaked Tubers in Nigeria

ABSTRACT

This work reports the comparison in the moisture absorption behavior, the extract yields and sensory evaluation of brown and yellow varieties of tiger nut (*Cyperus esculentus*) tubers, a rhizome cultivated in Nigeria, when soaked in water for tiger nut beverage production. For each tuber variety, 3g of it was steeped in 30ml of distilled water for 5 days and periodically re-weighed at 24-hour intervals until the tubers had attained saturated moisture content. Furthermore, 200g of each variety was steeped in 8ooml of sterile distilled water for periods of 0 hour (control), 24 hours, 48 hours and 96 hours, respectively. At the end of each time interval, the tubers were removed, ground in 800ml sterile distilled water, sieved, and the beverage liquid filtrate obtained measured as the percentage extract yield for the tuber sample. The 9-point Hedonic scale was used for sensory evaluation. The brown tubers showed a significantly higher moisture absorption behavior than the yellow tubers; the brown and yellow had the highest rate of moisture absorption ability of 52.22% and 35.56%, respectively, occurring after soaking for 24 hours. At same 24 hours of the soaking period, the resultant extracts obtained from the brown and yellow tubers were at a significant peak yields of 92% and 89.5%, respectively. Extracts from the brown tubers were preferred in taste and colour to those from the yellow variety. Water absorption potentials of tiger nut tubers during soaking process, has potential effects on the beverage extraction and quality.

Keywords: tiger nuts, brown variety, yellow variety, water absorption, sensory evaluation, extract yield

1. INTRODUCTION

Tiger nut is an underutilized crop of the family *Cyperaceae,* which produces rhizomes from the base and tubers that are somewhat spherical [1]. Tiger nut is commonly known as earth almond, chufa, yellow nut sedge and Zulu nuts. [2]. In Nigeria, some of its native names include 'Aya' in Hausa, 'Imumu' in Yoruba, 'Ofio' or 'akihausa' in Igbo [3]. Furthermore, two major varieties predominates namely; yellow and brown varieties which are readily available in the market especially in the Northern part of Nigeria with the yellow variety being the most popular because of its bigger size, attractive colour and fleshier body [3,4]. The tubers are widely consumed raw or unprocessed. They could be dried, mixed with groundnut or soaked in water for varied time-lengths of about 3 days [5]. They are particularly savoured for the production of dairy-like beverage extract which is non-alcoholic and consumed as soon as it is produced during leisure hours in family gatherings, local bars or in social functions like wedding/naming ceremonies. In recent times, it has increasingly become popular in many local social functions as substitute to industrially produced conventional carbonated drinks, perhaps probably due to its low price, and wide acceptance by the people.

Traditionally, the consumed beverage extract is prepared by steeping the tubers in water for different periods of time. This may range from a few hours to a full day; or for about three to four days, after which the harvested tubers could be consumed directly or sold in the public or hawked as delicacies. Little information is available on the effects of periods of steeping in water in terms of the moisture absorption characteristics of the soaked tubers and the beverage extract yield of the derived beverage. The information acquired will shore up efforts towards moving this traditional process into an industrial scale. This research aims to determine and compare the moisture absorption behavior and the extract yields from the two varieties of tiger nut tubers, locally available in the market, when soaked in water.

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2. MATERIAL AND METHODS

Collection of Samples:

The yellow and brown varieties of tiger nuts tubers, locally identified as the 'Big' and 'small' varieties, were purchased directly from local markets in Biliri (Gombe State) and used for the study. These were labeled "BBF" and "VSF," respectively, brought into the laboratory, and separately sorted as described by [6], in order to remove foreign materials, broken and damaged tubers. The sorted tubers were used in every experimental stage in the course of the study

Moisture absorption characteristics of tiger nut tubers steeped at ambient temperature

The steeping procedure described by [6], for the determination of rate of moisture absorption of tubers was used but with slight modification. For each variety, a weight of 3g of tuber was steeped in 30ml of distilled water contained in a McCartney bottle with cover, at room temperature for a period of five days. The tubers were removed, superficially dried with tissue paper, and weighed using an electronic balance (Adams AQT 1500, UK), at 24-hour intervals. Similarly, the volume of liquor left at the same time interval was also measured using a measuring cylinder. The tubers and the steeping liquor were returned into the McCartney bottles. The experiment was terminated when the tubers had attained saturation moisture content. Six replicates of this procedure were conducted.

A graph of the mean of the recorded weights of the tubers, at specified soaking times, was plotted. Also, the moisture contents of the tuber samples at each time interval was calculated based on the increase in tuber mass at corresponding times.

Water absorption rate = $(W_t - W_o)/W_o \times 100$

Where, W_t = weight of soaked tiger nut tubers at various time points, and W_o = weight of original tiger nut tubers

Determination of extract yields

Determination of the extract yield from the tiger nut tubers were as described by [7]. A total of three 200g sample of each variety of tiger nut tubers which had been washed several changes of sterile distilled water, were steeped in 800ml sterile distilled water for periods of 0 hour (control), 24 hours, 48 hours, 72 hours, and 96 hours, respectively (Figure 1).

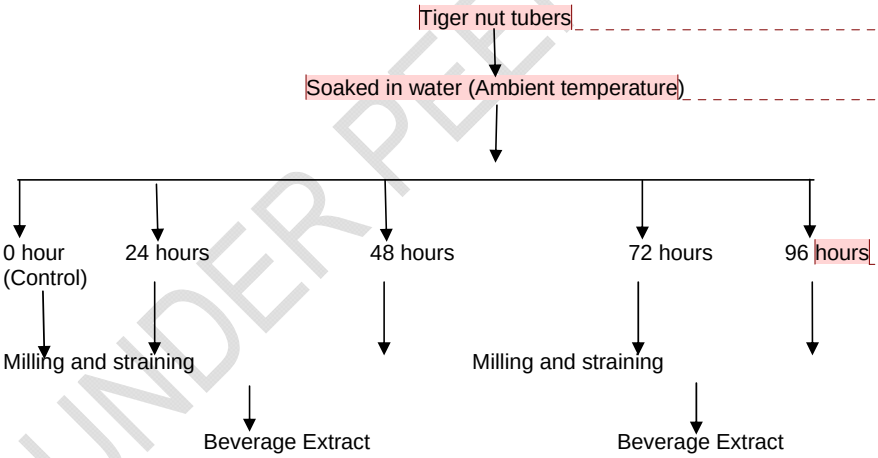

Figure 1: Determination of beverage extract yield process from soaked tiger nut tubers

At the end of each time interval mentioned, the steeping water was discarded and the tubers rinsed very well in sterile distilled water. The sieving of each blended sample in 800ml of sterile distilled water resulted in the removal of the chaff. What was left was the quantity of 'beverage' that was extracted. The quantity of the tiger nut beverage obtainable at the point of packaging into plastic bottles was recorded as the percentage extract yield for that tuber sample. The experiment was triplicated.

Sensory evaluation

Extracts from the different varieties were subjected to organoleptic assessment by a 43-member panel. Each panelist was requested to taste the samples one after the other and to indicate their degree of likeness based on the questionnaire provided. The samples were evaluated for colour,

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taste, aroma and general acceptability. They were required to score each parameter on a 9-point Hedonic scale, with 9 indicating 'Like extremely', and 1 indicating 'Dislike extremely'.

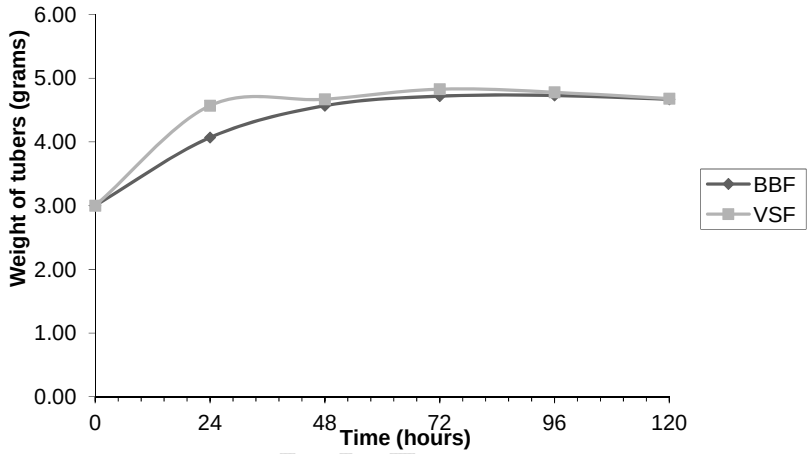
Statistical Analyses

All the different experimental data obtained, except those of sensory evaluation, were analyzed by two-way analysis of variance (ANOVA) using the Genstat Release 7.22 DE, version 2008 (VSN, International Limited). All sensory evaluation data were analyzed using the one-way ANOVA of the same software. Probability values ($P \leq 0.05$) were considered as statistically significant.

3. RESULTS AND DISCUSSION

Moisture absorption characteristics of tubers

The graph of the weight-change in the two varieties of tubers steeped in water at ambient temperature is shown in Figure 2.



KEY:

VSF-Brown variety **BBF- Yellow variety**

Figure 2: Weight-change in tubers of tiger nuts soaked in water at ambient temperature

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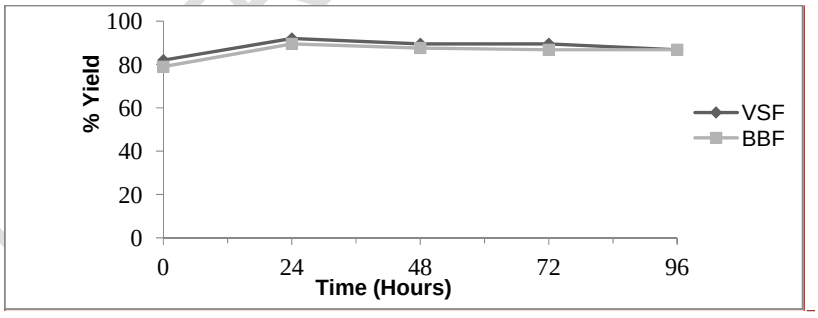
It was observed that the moisture absorption rate for the yellow and brown tubers was highest within the first 24 hours during which 35.56% and 52.22% of the total moisture absorption took place, respectively. These changes were significant. Additional increases of 15.00%, 5.83% and 1.39% occurred at 48 hours, 72 hours, and 96 hours, respectively, for the yellow tubers, while 3.34% and 5.55% were the additional increases recorded for the brown tubers at 48 hours and 72 hours, respectively. The moisture absorption changes were also significant at 48 hours and 72 hours in the yellow and brown tubers, respectively. At 96 hours, the brown tubers had had a 1.11% loss in weight.

It is worth noting that both the brown and yellow tuber curves became horizontal at 72 hours for brown tubers and 96 hours for yellow tubers when the weights of their soaked tubers were about 1.58 and 1.51 times, respectively, of the initial dry weight. This was when the peak weight-change had occurred, with weight change increases of 61.11% and 57.78%, respectively. The values obtained are less than the 2.2 times the original weights and 120% times their weights in water obtainable in soyabeans [8], after soaking in water for eight to ten hours. The traditional method of preparing retailed soaked tubers for eating purpose involves soaking the tubers in water at ambient temperature for about four to five days. Once every day, the steeping water is decanted and replaced with a fresh one. The understanding of the water absorption abilities of tiger nut tubers during soaking is of practical importance because the water absorbed governs the beverage extraction and quality. Generally, the brown tubers apparently showed a higher moisture absorption characteristic than the yellow. Soaking, essentially renders dried tiger nut, edible with ease and ensures acceptable sensory quality [9]. The amount of water absorbed in tiger nut tubers, at room temperature, has been reported to be directly related to the tuber size; the bigger the tuber, the higher the quantity of water absorbed [10]. Nevertheless, water absorption properties of plant materials are enhanced or hindered by some chemical components such as protein, starch, lipid and seed or tuber coat components [9]. The presence of one or some of these properties in the brown tubers might be the reason these tubers displayed improved moisture absorption property than the yellow, when obviously the same tubers were significantly smaller in size than the yellow [11].

Extract yield

The highest percentage yields of 89.5% and 92% from the yellow and brown tubers, respectively, were obtained from the 24-hour extracts (Figure 3); and these values were significant.



KEY:
VSF-Brown variety **BBF- Yellow variety**

Figure 3: Percentage yield of extracts from tiger nut tubers

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Afterwards, there was a gradual decline in the extract yields obtained as fermentation time increased. The period of the peak extract yield corresponded with when the tubers were at their most rapid intake in moisture absorption abilities, as earlier discussed.

Generally, the extract yields from the brown tubers were significantly higher than those from the yellow. This observation differed from the reports of [12] that the yellow tiger nut variety yield more extracts than other varieties in the Nigerian market.

Sensory evaluation of extracts

The results of the 43-panel sensory evaluation of extracts from the brown and yellow tiger nut tubers are shown in Figure 4 and Figure 5, respectively.

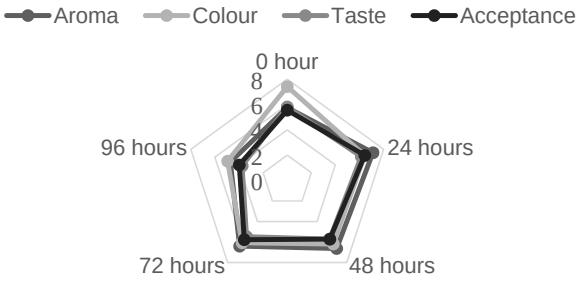

Figure 4: Mean sensory evaluation of extracts from brown tiger nut tubers

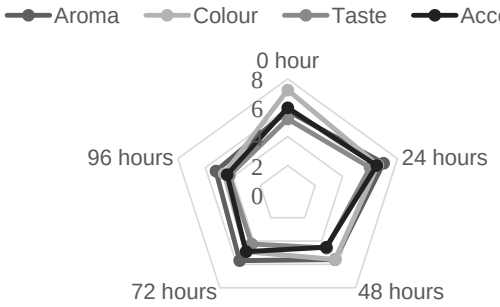

Figure 5: Mean sensory evaluation of extracts from yellow tiger nut tubers

In Figure 4, the 96-hour extract had mean scores less than 5 in all the parameters of sensory evaluation measured. The mean sensory evaluation score of less than 5 obtained for the 96-hour extract in all the parameters assessed, may be due to the prolonged natural or spontaneous fermentation and its subsequent production of unacceptable aroma, taste, colour and general acceptability. Tapped palm saps in Malaysia subjected to natural fermentation, have been reported by [13] to be highly fermentable in nature, with the results that products having fermentation lengths longer than 48 hours tend to possess unacceptable taste and aroma because of vinegar production. As regards aroma, even though the 24-hour extract had a higher mean score (7.12) than the 48-hour (6.63), the difference was not significant; however, the aroma from these extracts were significantly preferred to those from the 0-hour and 72- hour extracts. Furthermore, there was a significant preference in colour of the 0-hour extract obtained from the unsteeped brown tubers over those of other extracts from the same steeped tubers. This may be attributed to

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Maillard reaction. [14] have explained that Maillard reaction occurs when reducing sugars and amino acids or proteins in foods interact, resulting in brown coloured products responsible for the difference in colour between fresh and processed foods. It is believed that the tuber-steeping process (a form of food processing) could have created the opportunity for the interaction of these compounds. Lastly, the 24-hour extract was significantly preferred over the other extracts, in regard to general acceptability.

In Figure 5, the 0-hour and 24-hour extracts did not differ significantly in colour and taste from each other, but were highly significantly preferred to the other extracts from the same yellow tubers. Furthermore, the 24-hour extract was significantly preferred in aroma and general acceptability to the other extracts.

The observation that the aroma from the 24-hour and 48-hour extracts of the brown tubers was significantly preferred over those in 0-hour, 72-hour and 96-hour extracts from the same tubers, as well as that, the 24-hour extract from the yellow tubers was significantly preferred to those in other extracts from the same tuber, may be explained. These observations maybe attributed to the development of diversities of microorganisms in the course of the natural fermentation process. [15] have proffered that natural fermentation has the advantage of developing complex ('rich') flavours and aroma from the diversities of microorganisms occurring during fermentation process.

Figure 6, shows the mean sensory panel preference scores for the beverage extracts from the different varieties of tubers.

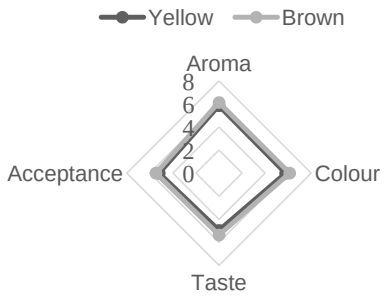

Figure 6: Mean sensory evaluation scores for beverage extracts from the different varieties of tubers

Extracts from the brown tubers were preferred in taste and colour to those from the yellow. In addition, extracts from the different tubers did not differ significantly in aroma and general acceptability. In all, the extracts from the brown tubers were preferred in taste and colour to those from the yellow variety. This observation is contrary to the report of [12] that the yellow variety is preferred to the brown and black varieties because of its inherent properties.

Conclusion

This study has shown that when soaked in water at room temperature, the brown and yellow tubers had the highest rate of moisture absorption ability of 52.22% and 35.56%, respectively, occurring after 24 hours of the soaking process. Furthermore, at same period, the resultant beverage extracts obtained from the soaked tubers were also at a significant peak yields of 92% and 89.5%, respectively. In sensory evaluation, the 24-hour extract from each of the studied tuber variety was significantly preferred in general acceptability over other extracts within the same tuber type. This information is essential at determining beverage extraction and quality in the quest to move tiger nut beverage production from a local process into a conventional technological form.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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