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Towards Quality Up-grading of the Concentrated Tabaldi *(Adansonia digitata* L.) Squash

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Abstract

Baobab (Adansonia digitata L.) is considered one of the most important forest trees which grow extensively in semi-arid Africa. It provides food, fibres, medicines and used as water store during emergency. The African Baobab's fruit has twice as much calcium as milk, rich in anti-oxidants, iron and potassium, and contains six-fold vitamin C of an orange. A part from these desirable nutritional attributes, Tabaldi squash has recently gained great popularity as an indigenous local drink for its availability, ease of preparation, little cost and freeness from harmful chemicals. However, the demand and acceptability of the consumers to Tabaldi squash is often negatively affected by the formation of a precipitate both at the bottom and top of Baobab fruit-based drink, which is a common phenomenon appearing immediately after its preparation. This study was an attempt to find out an appropriate treatment that can help eliminate the precipitated layer, which usually occurs in a concentrated Baobab squash. To realize that goal Carboxy Methyl Cellulose (CMC) and gum Arabic were additively used at different concentrations as stabilising agents. Our results revealed that 0.1% of CMC and 0.2% of gum Arabic were the best concentrations to eliminate or reduce the volume of a precipitate without affecting the product quality. From the taste point of view, the results obtained from organoleptic tests obviously showed that the consumer prefers untreated squash. More work is needed to innovate adequate techniques for up-grading the quality of Tabaldi squash not only at the local consumption level but also at the industry level.

Index Terms: Baobab/Tabaldi, *Adansonia digitata*, squash, quality.

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1. INTRODUCTION

Baobab (Adansonia digitata L.) is a well known tree in Sudan. It belongs to the family Bombacaceae and locally named Tabaldi. The habitat of this tree is the hot drier region of tropical Africa and it extends from the northern Transvaal and Namibia to Ethiopia, Sudan and the Southern Fringes of Sahara [1]. It possesses a unique fruit type with a woody pericarp surrounding a spongy pulp with reniform seeds [2]. In the rural areas especially in western Sudan the local people depend on Baobab pulp in the treatment of some diseases, and is often used as beverage. Fruit pulp is probably the most important food stuff portion. Analysis of ripe fruit showed an average of 8 – 7% moisture, 2.7% protein, 0.2% fats, 73,7% carbohydrates, 8.9% fibers and 5.8% ash [3]. The total lipid content was found to be 155 mg/g of dry weigh and that significant Linoleic acid was present [4]. The energy value of the pulp is similar to that of Baobab leaves. Special attention has been given to measuring vitamin C (Ascorbic acid) in Baobab fruit pulp due to occasional reports of high contents. [5] recorded 337 mg Ascorbic acid/100 g pulp for fruits in Nigeria. Pulp sweetness is provided by fructose, sucrose and glucose content. Natural Tabaldi fruit pulp is also acidic (low pH) due to the presence of organic acids including Citric acid, Tartaric, Malic, Quinic, Succinic as well as Ascorbic Acid [2]. The Baobab capsule pulp is reported to have a high content of vitamin C and one can easily obtain a drink with vitamin C

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content equivalent to that of orange juices. Freshly-prepared juice contains variable amounts of fine cellular debris with colloidal material, pectic substances, gums, proteins and other components. Spontaneous clarification usually take place after the formation of protein-tannin complexes, insoluble pectates, or multiple changes giving precipitates containing suspended material and a range of juice components. Polysaccharides are regarded the main cause of precipitation in fruit drinks. Among carbohydrates, pectic substances are defined by [6] as a group of complex colloidal carbohydrates derivatives, which occur in or prepared from plants. Tabaldi fruit pulp is rich in pectin, most of it being water-soluble with a low content of protopectin. Total pectin in Baobab fruit pulp was reported to be 56.2% [7]. Studies showed that cellulose ranks second in importance in the formation of precipitate in fruit drinks due to its high molecular weight and starch probably ranks third [8]. The formation of a precipitate at the bottom and top of Tabaldi fruit based drink is a common phenomenon. Its depth varies according to the method of preparation. To address this problem of precipitate formation, stabilizing additives CMC and gum Arabic were used to reduce or eliminate the precipitated layer in a concentrated Tabaldi squash. It is well known that a variety of cellulose gum types is available offering a viscosity and particle size range to convey the desired properties. Gums are cheap, easily soluble in cold or warm water, impart neither taste nor odour, incompatible with the ingredients contained in fruit drinks, withstands the low pH value found in fruit drinks, and improve body and mouth feel. With respect to its specific properties, gums inhibit the pulp deposit during storage, suppress the formation of an oil ring at the neck of bottle, improve the appearance of the product and mask the after taste to certain artificial sweeteners and the modulate perception of flavour. The second additive we employed in this investigation is CMC whose concentration depends on the TSS, on the pulp content in the base or in the juice and on the emulsion used, but typically between 0.1 - 0.4% [9]. Sodium CMC meets the purity criteria set by the European Union (EU), Food and Agricultural Organization (FAO), World Health Organization (WHO) and by the Food Chemicals Codex of USA for food grade CMC. The European Commission (EC) has assigned the number of E466 to CMC in the classification of food additives of the EU. The new EU directive on miscellaneous additives classifies CMC in the Annex 1 as "Generally permitted food additives for use in foodstuff". Many countries in Europe allow the use of C.M.C in food [9].

2. MATERIALS AND METHODS

Source of Tabaldi fruits

Fully ripened edible portion of Tabaldi (Adansonia digitata L.) fresh fruits were purchased from Omdurman local market, Sudan as bulk fruits. The experiments carried out during this study consisted of different preparation methods for extraction of pulp for the preparation of Tabaldi squash.

Preparation of Tabaldi squash

Two experiments were conducted to determine the best soaking time and soaking ratio for preparation of the squash from Tabaldi (Adansonia digitata L.) fruit pulp.

Determination of the best soaking ratio

Five samples of dried edible portion of Tabaldi fruits were weighed and five dilutions were chosen using tap water (1:1, 1:2, 1:3, 1:4 and 1:5). These samples were then soaked for two hours at ambient temperature. The best dilution was chosen according to high yields and better taste after preparation of a ready-to-serve drink from each dilution.

Determination of the best soaking time (Soaking in cold water)

The best soaking ratio determined previously was used for determination of the best soaking time. Equal portions of the sample were weighed and soaked for 1, 2, 3, 4 and 5 hours at ambient temperature using cold water. A ready-to-serve drink from these samples was prepared after addition of 0.1% citric acid and the best soaking time was chosen accordingly.

Soaking in hot water

Similarly, given the best soaking ratio determined previously five samples of Tabaldi fruit were weighed and the best dilutions were used and soaked for 1, 2, 3, 4 and 5 hours using hot water at the same ambient temperature. A ready-to-serve drink from each sample was prepared and the best soaking time was chosen accordingly.

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Concentrated Tabaldi squash

The best soaking time and best soaking ratio determined were used for preparation of the concentrated Tabaldi squash having a total soluble solids (TSS) of 45%. The prepared squash was left for three hours for observation of the separation phenomenon and the volume of the precipitate formed was measured after 24 hours.

Concentrated squash treatment

The concentrated Tabaldi squash prepared was treated with two additives, gum Arabic and CMC as follows: 0.1%, 0.2%, 0.3%, 0.4% and 0.5% gum Arabic and 0.025%, 0.05%, 0.075% and 0.1% of CMC. Treatments were applied separately and the samples were kept standing for the observation of the separation phenomenon. The best percentage from the gum Arabic and CMC were chosen on the basis of the least volume of a precipitate formed. The best ratios from gum Arabic and CMC were used in a concentrated Tabaldi squash prepared by tap water and distilled water. After addition of gum Arabic and CMC to the concentrated Tabaldi squash gentle stirring for homogenization was carried out. Heat treatment was applied, and then the squash was bottled in glass containers and finally sealed using a capping machine. To evaluate the impact of usin gum Arabic and CMC on the quality of our prepared Tabaldi squash, chemical analysis was performed which involved the quantification of total soluble solids (TSS), pH, volume of the extract, viscosity and the titratable acidity.

Total Soluble Solids (TSS)

For determination of the TSS in the concentrated Tabaldi squash, the hand refractometer was used. It was expressed as Brix 0–50 [10].

Ph

The pH value was determined using a pH-meter (Hanna instruments 8521). Two standard buffer solutions of pH 4.00 and 7.00 were used for calibration of the pH meter at room temperature. The pH was allowed to stabilize for one minute and then the pH of the samples were read directly. The reading was repeated three times for each sample.

Volume of the extract

The volume of the extract was determined using a measuring cylinder.

The viscosity

The viscosity of the treated squash was determined with the aid of Oswald tube. (volac – Bs. Ip, CF – 71 – size 150) by recording the time of the solution to run from point A to point B.

Titrable acidity (Determination of total acids)

Total acids were determined by titrating 10 ml of 10% solution against 0.1N NaOH to pH 8.1. Total acids were expressed as citric acid according to the equation below:

$$\text{Total acidity (\%)} = \frac{0.1 \times \text{equivalent weight of citric acid} \times \text{Normality of NaOH} \times \text{titre}}{\text{Weight of a sample}}$$

Organoleptic test

To further assess the effect of gum Arabic and CMC on the quality of Tabaldi squash we performed organoleptic tests to get some feedback from the consumer, a small mirror reflecting quality of the product. All the samples described previously were subjected to a panel test in Food Research Centre, Shambat – Sudan to select the most preferred sample using ranking test described by [11]. Firstly, the sample was divided into four portions and from each the best sample was chosen.

Statistical analysis

Data was statistically treated as a Completely Randomized Design (CRD) design experiment. Analysis of variance (ANOVA) and means separation by the Least Significant Difference (LSD) was carried out according to [12]. The symbols used indicate the following: **highly significant, *significant, NS not significant, CV coefficient of variation.

3. RESULTS & DISCUSSION

This study was conducted to evaluate the quality of the concentrated Tabaldi squash when treated with two stabilizing additives; gum Arabic and CMC in an attempt to eliminate the precipitated layer in the concentrated squash

Determination of the best soaking ratio

As indicated in Table 1 below five dilutions were used. Noticeably, volume of the extract increased gradually with progressive dilution, while the TSS decreased with increasing the dilution. This might be attributed to the increase in the amount of water added. The taste decreased from very strong (in the least soaking ratio, 1:1) to very weak (in the greatest soaking ratio, 1:5). Accordingly, the best soaking ratio (1:2), Tabaldi : Water was determined on a taste basis.

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Table (1): Determination of the best soaking ratio

Ratios	1:1	1:2	1:3	1:4	1:5
Volume (ml)	36	99	158	213	280
T.S.S	6.0	3.0	2.0	0.5	Zero
Taste	very strong	Strong	Strong	Weak	very week

Determination of the best soaking time using tap water

The best soaking ratio 1:2 was used for five time intervals 1, 2, 3, 4 and 5 hours (Table 2). The results showed that the volume of the extract decreased progressively with increasing the soaking time. This might be attributed to the high prevailing temperature, which caused water evaporation during soaking. In contrast, the TSS increased from 2% in one hour soaking to 2.5% in 2 hours soaking time. This increment in TSS can be explained by the fact that with increasing the soaking time, more soluble solids will likely be extracted. After two hours from the commencement of soaking, no change was observed and the TSS assumed a constant level (2.5%) during the rest of the soaking time. The pH value slightly decreased with increasing the soaking time up to three hours then increased during the last two hours of the soaking time. The taste of the extract changed from very weak (in the first hour) to very strong (in the 4th and 5th hour). The best soaking time was determined after the preparation of a ready-to-serve drink from each extract to be four hours at cold water.

Table (2): Determination of the soaking time (using tap water)

Soaking time (h)	1hr	2hrs	3hrs	4hrs	5hrs
Volume (ml)	85	90	93	95	100
T.S.S (%)	2	2.5	2.5	2.5	2.5
pH	2.4	2.3	2.2	2.3	2.4
Taste	very weak	Weak	Strong	very strong	very strong

Determination of soaking time using hot water

As shown below (Table 3) using the soaking ratio 1:2 (Tabaldi: Hot water) for different soaking times, it was found that the volume of the extract decreased with increasing soaking time due to the evaporation of water by the high surrounding temperature and the temperature already applied (80ºC). No change was observed in both pH and TSS. The taste ranged from strong (in one hour) to very strong (in 4 hours). So, economically, one hour was assigned as the best soaking time (Table 3).

Table (3): Determination of the soaking time using hot water (80°C)

Soaking time (h)	1	2	3	4
Volume (ml)	97	94	90	89
T.S.S (%)	2.5	2.5	2.5	2.5
pH	3.1	3.00	3.00	3.1
Taste	Strong	Strong	Strong	Very strong

Volume of the precipitate in a concentrated Tabaldi squash

Four samples of the concentrated Tabaldi squash were prepared, two were prepared using hot water and the other two were prepared using tap water. Two samples; one with hot water and the other with tap water were prepared and put in two measuring cylinders to observe the formation of a precipitate. The two other samples were prepared and subjected to heat treatment, then put in two measuring cylinders. The volume of precipitate was about 10 mm/100 mm concentrate in all samples. The formation of a precipitate layer was observed to be rapid in the heated squash and in the squash prepared with hot water. It could be speculated that formation of a precipitate relatively more rapid in heated water than that in the unheated tap water might be due to protein coagulation that move to the bottom forming a precipitate layer.

Determination of the best ratio of gum Arabic and CMC

The prepared squash was treated with various levels of both gum Arabic and CMC. The ratios of 0.1% CMC and 0.2% gum Arabic were found to be the best ratios that gave the least volume of a precipitate layer in a concentrated Tabaldi squash using hot water. The least level of the precipitate formed in the treated squash is most likely due to the increasing viscosity of the squash by additions of gum Arabic and CMC. So, the particles could not move easily to the bottom to form a precipitate layer.

Physico-chemical properties of the treated squash

The data presented showed that in the treated squash prepared from hot tap water and hot distilled water, the TSS increased in all treated samples compared to the untreated control (Table 4). This increment of TSS in the treated squash across all treatment might be interpreted with the fact that both gum Arabic and CMC contain some soluble sugars, which increase the TSS level in the treated squash. The sugar composition of crude commercial grade and processed gum Arabic was noted to be between 22.21–30.92, 42.33 and 58.16 Arabinose, Rhameinose and Galactose, respectively [13]. The pH was relatively constant, crude gum Arabic is slightly acidic. Recording the movement time of the concentrate from point A to point B in Oswald tube, it was found that viscosity of the treated squash was increased compared to that of the control. The total acidity of the treated squash was relatively constant.

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Table (4): Physio-chemical properties of treated Tabaldi Squash

Treatment	DG	DC	TG	TC	Control
T.S.S(%)	45.5	45.5	45.5	45.5	45
pH	3	3.1	3.1	3.2	3.1
Time (min.)	5	5	4	5	3
Acidity (citric acid)	0.14	0.2	0.17	0.2	0.2

Whereas:

DG: concentrated Tabaldi squash, prepared from distilled water and treated with gum Arabic.

DC: concentrated Tabaldi squash, prepared from distilled water and treated with CMC.

TG: concentrated Tabaldi squash, prepared from tap water and treated with gum Arabic.

TC: concentrated Tabaldi squash, prepared from tap water and treated with CMC.

Time: the time for the concentrated Tabaldi squash to run from point (A) to point (B)

Sensory evaluation

Panel test was done for two samples of the concentrated Tabaldi squash prepared from distilled water (one treated with gum Arabic and the other with CMC. Table (5) below shows that the colour of the treated squash was more acceptable than the untreated. The taste and overall acceptability were better in the control as people are more accustomed to the natural taste of Tabaldi than that of the treated one.

Table (5): Sensory evaluation results for treated Tabaldi squash using distilled water

Treatment	Colour (%)	Taste (%)	Overall acceptability %
DG	79.4	73.0	75.7
DC	79.4	71.3	71.3
Control	62.0	80.3	77.8
L.S.D	20.03^{NS}	20.55^{NS}	20.63^{NS}
CV%	38.34	39.34	39.48

Panel test was also done for the other two samples prepared by hot tap water and treated with gum Arabic and CMC. As indicated below (Table 6) the colour, taste, and the overall acceptability were more acceptable in the treated squash compared to the control.

Table (6): Sensory evaluation of treated Tabaldi squash (using tap water)

Treatment	Colour %	Taste %	Over all acceptability %
TG	90.7	78.39	81.49
TC	80.8	85.0	80.8
Control	47.9	59.9	59.6
L.S.D	23.68^{**}	19.68^{NS}	19.76^{NS}
C.V%	33.65	37.67	37.82

The overall acceptability of the squash treated with gum Arabic prepared from tap water and distilled water was presented in table (7). The colour of the squash prepared from tap water showed the highest acceptability (92.1%) compared to 77% in distilled water. However, the taste was more acceptable in the case of the distilled water than that in the tap water.

Table (7): Overall acceptability of Tabaldi squash treated with gum Arabic using tap and distilled water

Treatment	Colour(%)	Taste (%)	Over all acceptability (%)
DG	77.0	92.6	82.7
TG	92.1	70.8	87.8
L.S.D	20.19^{NS}	18.70^{*}	20.90^{NS}
C.V%	33.63	35.03	34.82

The acceptability of the squash treated with CMC prepared from tap water and distilled water was presented in table (8). The colour was more acceptable in the squash prepared from distilled water than that prepared from the tap water. The taste was more acceptable in the case of tap water than that in the distilled water. The overall acceptability in the case of distilled water showed 87.8% more than that in the case of tap water 82.7%.

Table (8) Acceptability of Tabaldi squash treated with CMC using tap and distilled water

Treatment	Color %	Taste %	Acceptability %
DC	92.1	77.1	87.8
TC	77.0	92.1	82.7
L.S.D	20.19^{NS}	20.19^{NS}	20.19^{NS}
S.V%	33.63	33.63	34.82

4. CONCLUSION

The present study was to test both gum Arabic and CMC additives and their possible potential in eliminating or reducing the precipitated layer, which is normally formed in a concentrated Tabaldi squash. Our findings showed that Using of 0.1% CMC and 0.2% gum Arabic as stabilizing agents in the concentrated Tabaldi squash is an adequate method to eliminate or reduce the precipitated layer in the squash. Furthermore, in the light of our current results it could be highlighted that the formation of a precipitate layer is influenced by the type of water used. Soaking in distilled water gave the least volume of a precipitate layer. However, the temperature of soaking water affect greatly the soaking time. The higher the temperature, the less time required for soaking. Overall, though formation of a precipitated layer in Tabaldi squash is a natural phenomenon, which often lessens its quality by the consumer, the current investigation provided a piece of evidence that this precipitate could be eliminated or reduced by addition of 0.1% CMC, 0.2% gum Arabic. Further studies are required for identification of the substances that might be responsible for the precipitate formation in Tabaldi squash. Knowledge of nature of such substances would definitely pave way towards innovation of better techniques for the production of a more acceptable concentrated Tabaldi squash to the consumer

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