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RESEARCH ARTICLE

PREPARATION OF DOUM (*HYPHAENETHEBAICA*) DRINK

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ABSTRACT

In this study, doum fruit pulp (slices) was used to prepare four types of beverages in addition to the traditional doum drink. Distilled water, gum Arabic, CMC and filtration treatments were separately used to prevent precipitate formation (pulp sedimentation). All products were examined for physicochemical, microbial and organoleptic qualities. The traditional doum drink showed a pH value of 5.1, 153 mg/100ml acidity, 7.3 °Brix total soluble solids and 12.83 cps viscosity. It also contained 49.11, 19.33 and 30.64 (mg/100 ml) total sugars, reducing sugars and non-reducing sugars, respectively. Doum drink prepared using distilled water revealed the same pH (5.15), significantly ($P \leq 0.05$) lower acidity (134.13 mg/100 ml), TSS (6.0 Brix), viscosity (11.50 cps) and significantly ($P \leq 0.05$) higher total reducing and non reducing sugars (66.84, 22.05 and 44.72 mg/100 ml, respectively) compared to the traditional one. When gum Arabic and CMC were separately added, the beverage showed significantly ($P \leq 0.05$) lower pH (4.76 and 5.03, respectively), but significantly ($P \leq 0.05$) higher acidity, TSS, viscosity as well as considerably higher total, reducing and non-reducing sugars compared to the control. Filtration resulted in a doum beverage with the same pH (5.16), significantly ($P \leq 0.05$) lower acidity (93.87 mg/100 ml) TSS (7.0 Brix) viscosity (9.7 cps), but significantly ($P \leq 0.05$) higher total, reducing and non reducing sugars (84.20, 47.01 and 36.98, respectively). The fresh traditional doum beverage showed low bacterial total viable count (TVC) of 1.8×10^3 cfu/ml. The TVC was drastically reduced to 3.3×10^2 cfu/ml due to filtration. Manipulation with distilled water, CMC and gum Arabic increased the TVC of the doum drink to $2.9 \times 10^3 - 17.6 \times 10^3$ cfu/ml. The five types of doum drinks proved to be free from *Salmonella*. The filtered doum drink proved to be organoleptically the best due to its out-standing acceptable sensory properties compared to the other products; in addition it was nearly precipitate free.

INTRODUCTION

Fruit juices are important in human nutrition far beyond its use as a refreshing source of liquid. Many fruits contain a variety of minor ingredients, particularly vitamins and minerals, as well as carbohydrates, which are the predominant solid component. Although fruit contains small amounts of protein and fat, these are not important ingredients of juices (Ashurst, 2005). Fruit juices and soft drinks are widely consumed in ever-increasing quantities and are very important commodities in the trade of most countries. They are available in essentially the same form almost anywhere in the world from polar basis to the tropics, and from the largest developed nations to small and less developed countries. Soft drinks and fruit juices are available in bottles, cans, laminated paper packs, pouches, cups and almost every other form of packaging known. Usually the juices were pressed from over-ripe fruits and drunk immediately. If they hold for one day or more they partially ferment. The development of ready-to-drink juices, blends, concentrates and dry mixes has come about through series of

technical developments during the last half century (Curtis, 1997). Historically, the doum palm, *Hyphaenethebaica*, has been cultivated in Egypt since ancient times and has long been considered a sacred tree, symbolizing masculine strength. The fruit has a quite spongy wall that is very rich in carbohydrates and is a good source of iron and niacin (FAO/WHO, 1988). Fruit pulp of doum, that covering of the fruit is edible and can either be pounded to form a powder or cut off in slices, the powder is often dried then added to food as flavoring agent; fruit pulp is chewed to control hypertension. Salih (1991) reported that doum Minerals were found to be 0.13%, 0.18%, 0.09% and 3.02% for Ca, Mg, Na, and K respectively. Doum extract could be an important dietary source of phenolic compounds with high antioxidant and anticancer activities (AbouElalla, 2009). The pulp is known to have antioxidant properties, antimicrobial activity and can also be used in stabilizing food against oxidative deterioration (Mohamed *et al.*, 2010).

Justification of the research: The formation of precipitated layer at the bottom of doum fruit traditional drink was the main problem hindering the industrial exploitation of doum pulp as base for commercial drinks, its high fiber content or due to the

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large size of doum fiber particles. Generally, polysaccharides are the main cause of precipitation of the fruit drinks. Cellulose ranks second in importance in the formation of a pre-precipitated layer in fruit beverages due to their high molecular weights. Starch probably ranks third in the formation of precipitate. In addition, the hardness of water, the method of filtering of the extract, type of the fruit and the viscosity of drink probably affect formation of precipitates (A. Azimet *et al.*, 1981). Therefore, stabilizing additives have been widely used in processed fruit drinks.

The objectives of the present study were:

- To produce different doum drinks (traditional, with distilled water, with gum Arabic or CMC and filtered).
- To reduce or eliminate the precipitated layer so as to produce an attractive and marketable drink.
- To determine some of the physicochemical and microbiological properties of the prepared doum drinks.
- To evaluate the above-mentioned products organoleptically.

MATERIALS AND METHODS

Materials

Cultural Research Station, North Kordofan State, Sudan. Gum Arabic powder was obtained from Warm Seas Company, Elobied-Sudan. CMC was provided by Crystal Company, Khartoum North, Sudan.

Five different types of doum drinks were prepared as follows:

Traditional method of doum drink preparation: The traditional method commonly used in western Sudan (Nyala town, South Darfur State) was adopted. About 250g slices of doum fruit pulp were weighed, soaked in 3 liter tap water for 5 hours, sieved using product was filled in polyethylene terephthalate (PET) bottles then kept for further investigation and named as Doumtra.

Doum drink with distilled water: Two hundred and fifty grams of doum fruit pulp were weighed, steeped. Then 150 g refined cane sugar were added. The drink was packed in PET bottles then subjected to pasteurization (65-70°C, 15 min.) and designated as Doumdistl.

Doum drink with gum Arabic: The same method described in 2.1.2 was carried out with the addition of 3% gum Arabic powder and labeled as Doum gum.

Doum with Carboxy Methyl Cellulose (CMC): The same procedure described in 2.1.2 was carried out with the addition of 1g/l CMC and named as Doum CMC.

Doum drink prepared by filtration: The same method described in 2.1.2 was followed and the drink was filtered using Whatman filter paper (No.4) and named as Doumfiltr.

physico-chemical Analysis

pH: The pH 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.

Titration acidity: Total acidity (mg/100 ml) expressed as citric acid was determined according to Ranganna (1977). Total acidity was calculated using the following equation:

$$\text{Total acidity (mg citric acid/100 ml drink)} = \frac{\text{ml(NaOH)} \times \text{N(NaOH)} \times \text{eq.wt acid} \times 100}{10}$$

Total Soluble Solids (TSS)

The total soluble solids (TSS) were determined using hand refractometer with ° Brix-degree scale 0 – 50 according to AOAC (1984) standard methods.

Viscosity

The viscosity of each sample (50 ml) was measured according to the method of Quinn and Beuchat (1975) using Brookfield viscometer, spindle no. 4, speed 30 rpm at room temperature. The viscosity was expressed in centipoises (cps).

Total and reducing sugars

Total and reducing sugars were determined according to Lane and Enontitrometric methods (AOAC, 1984).

Microbiological Analysis

Total viable count of bacteria (TVC): Plate count agar (PCA), prepared according to the instructions of the manufacturers was used for enumeration of bacteria. The TVC (cfu/ml) was determined using a colony counter.

Yeast and mould enumeration: Potato dextrose agar (PDA), prepared according to the instructions of the manufacturers, was used for enumeration of yeast and mould. Counting (cfu/ml) was carried out by colony counter.

Total coli form bacteria: MacConkey broth, prepared according to the constructions of the manufacturers, was used for detection of coli form bacteria by the multiple tube technique. Positive tubes gave gas in the Durham tubes and change the color of the medium.

Detection of Salmonella: Nutrient broth, prepared according to the instruction of the manufacturers was used for detection of *Salmonella*. Black sheen discrete colonies indicate the presence of *salmonella*.

Detection of Staphylococcus aureus: Baird parker medium, prepared according to the instruction of the manufacturers, was used for detection of *Staphylococcus aureus*. Black shiny convex colonies surrounded by clearing zone of 2 to 4 min. in width indicate the presence of *Staphylococcus aureus*.

Organoleptic Evaluation: The five types of doum drinks were subjected to panel test which was carried out at the lab of Dept. of Biochemistry and Food Science, University of Kordofan. Samples were tested using Ranking Test as described by Ihekoronye and Ngoddy (1985). Judges were requested to examine the products according to quality attributes and then

rank the products from the best (rank 1) to the least in quality (last rank). Results were statistically analyzed by Tables provided by Ihekoronye and Ngoddy (1985) at 5% level of significance.

Statistical Analysis:Data assessed by analysis of variance (ANOVA) (Snedecor and Cochran, RD with three replicates. Means were compared using Duncan's Mutiple-Range Test (Duncan, 1955) with probability ($P \leq 0.05$).

RESULTS AND DISCUSSION

In this study, Doum fruit pulp slices were used to prepare five types of drinks: using the traditional method (Doumtra); distilled water (Doumdistl); 3% gum Arabic (Doum gum); 1g/L Carboxy Methyl Cellulose employed to eliminate or reduce pulp sedimentation.

The Physicochemical Properties of Doum Drinks:The physicochemical properties of the five doum drinks are presented in Table (3.1).

Table 3.1. The physicochemical properties of doum drinks

Samples	pH	Titration acidity (mg/100 ml)	TSS (°Brix)	Viscosity (cps)
Doumtra	5.10 ^a	153.00 ^b	7.30 ^c 12.83 ^c	
Doum dist	5.15 ^a	134.13 ^c	6.00 ^c	11.50 ^d
Doum gum	4.76 ^b	213.33 ^a	10.00 ^a	17.50 ^a
Doumcmc	5.03 ^b	157.87 ^b	8.00 ^b	16.83 ^b
Doum filt	5.16 ^a	93.87 ^d	7.00 ^d	9.70 ^c

-Each value is an average of three replicates

-Means not sharing a similar superscript letter in a column are significantly different at ($P \leq 0.05$) as assessed by Duncan's Multiple Range test.

pH values:

The pH of the traditional doum drink was 5.10. Doumfiltration and doumdistillation showed pH values of 5.16 and 5.15, respectively. No significant differences ($P \leq 0.05$) were observed among the above-mentioned beverages. On the other hand, Doum gum and Doum CMC drinks demonstrated analogous pH values of 4.76 and 5.03, respectively. Present findings were higher than the range of 2.5-4.0, at which satisfactory results of beverages preservation are achieved (Woodroof and Phillips, 1978). Recently, the pH of doum beverage primed from concentrated (53 TSS) doum pulp extract was found to be 4.0 (Abaker, 2010). pH values ranging from 2.9 to 3.3 were reported for baobab beverages containing different concentrations of gum Arabic (Abdalla *et al.*, 2010). Moreover, Alrikain (2004) reported pH value of 4.0 for the fresh admired Sudanese drink gudeim prepared from the wild fruits of *Greviatenax*. It is obvious that application of gum Arabic and CMC significantly ($P \leq 0.05$) reduced the pH value compared to Doumtra (control), whereas filtration and using distilled water did not affect the pH.

Titration acidity:The drink that prepared by addition of gum Arabic showed the significantly ($P \leq 0.05$) highest acidity (213.33 mg citric acid/100 ml). On the contrary, Doum CMC, Doumtra and Doumdistillation drinks demonstrated significantly ($P \leq 0.05$) lower acidity (157.87, 153.00 and 134.13 mg/100 ml, sequentially). However, the filtrated drink (Doumfiltration) exhibit the significantly ($P \leq 0.05$) lowest acidity (93.87 mg/100 ml).

Lately, Abaker (2010) reported 31-34 mg/100 ml total acidity for different doum beverages. Gum Arabic significantly ($P \leq 0.05$) elevated the acidity matched to the control. In contrast, filtration and preparation with distilled water significantly ($P \leq 0.05$) reduced it. Addition of CMC exerted no effect on the acidity of doum drink.

Total soluble solids (TSS): As presented in Table (3.1), the tested drinks showed significantly different ($P \leq 0.05$) total soluble solids. Filtration as well as utilizing distilled water notably reduced the TSS from 7.3 Brix sequentially ($P \leq 0.05$) to 7.0 and 6.0 Brix. Conversely, application of CMC and gum Arabic markedly raised the Brix to 8.0 and 10.0, respectively. The exceeding TSS values agree with recommended range of 7.0 to 14.0 Brix of the American Beverage Association. Abaker (2010) reported Brix values ranging from 12.0 to 14.0 for carbonated and non-carbonated drinks. However, related total soluble solids value of 9.4 Brix was reported for gudeim fresh juice (Alrikain, 2004). For Roselly carbonated beverage 14.0 Brix was formerly reported (Abd Allah, 2007), likewise a higher value of 15.7 Brix was reported for tamarind carbonated drink (Mustafa, 2007).

Viscosity:Concerning viscosity, significant ($P \leq 0.05$) variations were observed among the different doum beverages (Table 3.1). Elevated values of 17.5 and 16.8 cps were recorded consecutively for Doum gum and Doum CMC, whereas Doumtra and Doumdistillation exhibited moderate figures of 12.8 and 11.5 cps, respectively. Doumfiltration gave lower viscosity of 9.7 cps. Current results were comparable to the range 6.7-15.5 cps reported for baobab beverages containing 1 to 3% spray dried gum Arabic (Abdalla *et al.*, 2010). Gum Arabic and CMC brought significant ($P \leq 0.05$) enhancement in the viscosity of the drinks compared to Doumtra. Using distilled water as well as filtration apparently reduced the viscosity. Recently, Abdalla *et al.*, (2010) concluded that the gradual increase in the percentage of cleaned gum (from 1 to 3%) resulted in a corresponding elevation in the viscosity of baobab beverages.

Sugars Content of Doum Drinks: Total reducing and non-reducing sugars contents (mg/100 ml) are shown in Table (3.2).

Total Sugars: The five types of doum drinks were found to contain significantly ($P \leq 0.05$) different total sugar contents. Doumfiltration showed the maximum level (84.20 mg/100 ml) followed by Doum CMC (80.80 mg/100 ml) then Doum gum (71.93 mg/100 ml) and Doumdistillation (66.84 mg/100 ml). though, Doumtra demonstrated the minimum total sugar concentration (49.11 mg/100 ml). It is clear that the four treatments significantly ($P \leq 0.05$) increased the total sugar content of doum drinks. Formerly, total sugars contents of baobab beverages containing 1-3% gum Arabic were found to be 301.2-336.7 mg/100 ml (Abdalla *et al.*, 2010).The gradual increase in the total sugar contents can be attributed to the gradual clarification of the drinks which may improve the sensitivity of the method used for determination of the total sugars.

Reducing sugars: Interestingly, reducing sugars contents showed the same trend of the total sugars. The uppermost concentration (47.01 mg/100 ml) was found in Doumfiltration, reasonable contents (39.89 and 25.53 mg/100 ml) were detected sequentially ($P \leq 0.05$) in Doum CMC and Doum gum.

The lowest concentration (19.33 mg/100 ml) was exhibited by the traditional drink. Abdallet *et al.*, (2010) stated that the reducing sugars content of baobab beverages containing cleaned gum was in the range of 274.5 to 290.5 mg/100 ml, while that for beverages containing spray dried gum varied from 295.7 to 313.9 mg/100 ml.

Non-reducing sugars:As indicated in Table (3.2), Doumdistl and Doum gum beverages showed equivalent levels of non-reducing sugars (44.72 and 47.07 mg/100 ml, respectively), which were significantly ($P \leq 0.05$) higher compared to the remaining products. Doum CMC drink contained significantly ($P \leq 0.05$) superior non-reducing sugars content (40.96 mg/100 ml) matched to that for Doumfilt and Doumtra (36.98 and 30.46 mg/100 ml, respectively). However, the latter two drinks demonstrated significantly ($P \leq 0.05$) different non-reducing sugars concentrations.

Organoleptic Test of Doum Drinks:According to the results of panel test (ranking) shown in Table (3.4), doumfilt drink showed significantly ($P \leq 0.05$) the best color, appearance, precipitate volume and overall quality when compared to the rest of products. Doum gum beverage exhibited the most inferior quality characteristics. Doumtra, Doumdistl and Doum CMC drinks showed significantly identical color, appearance, precipitate volume and overall quality, which was superior to that of Doum gum. Interestingly, the five products gained significantly ($P \leq 0.05$) related aroma and bodyness, even so Doumfilt was relatively the most excellent. Apparently, the taste and bodyness attributes were not affected by the treatments (filtration as well as addition of gum and CMC). On the other hand, filtration improved color, appearance, overall quality and reduced the precipitate volume. Nevertheless, addition of CMC only slightly reduced the precipitate volume, but significantly ($P \leq 0.05$) defect the other quality

Table 3.2. Non-reducing sugars in doum drink

Samples	Total sugars	Reducing sugars	Non-reducing Sugars
Doum tra	49.11 ^c	19.33 ^c	30.64 ^d
Doum distl	66.84 ^d	22.07 ^d	44.72 ^a
Doum gum	71.93 ^c	25.53 ^c	47.07 ^a
Doum CMC	80.80 ^b	39.89 ^b	40.96 ^b
Doumfilt	84.20 ^a	47.01 ^a	36.98 ^e

Each value is an average of three replicates.

Means not sharing a similar superscript letter in a column are significantly different at ($P \leq 0.05$) as assessed by Duncan's Multiple Range test

Table 3.3. Microbial assay of doum drinks

Samples	Total viable count of bacteria (cfu/ml)	Total count of Fungi-Yeast and mould	Total coliform	<i>S. aureus</i>	<i>Salmonella</i>
Doum tra	1.8×10^3	Nil	-ve	-ve	-ve
Doum distl	2.9×10^3	Nil	-ve	-ve	-ve
Doum gum	17.6×10^3	Nil	-ve	-ve	-ve
Doum cmc	8.3×10^3	Nil	-ve	-ve	-ve
Doum filt	3.3×10^2	Nil	-ve	-ve	-ve

Table 3.4. Organoleptic test of doum drinks (values are sum of ranks)

Samples Code	Color	Aroma	Taste	Precipitate	Appearance	Mouth feeling	Overall quality
Doumtra	55 ^b	44 ^b	49 ^b	59 ^b	50 ^b	40 ^b	49 ^b
Doumdistl	43 ^b	48 ^b	50 ^b	42 ^b	46 ^b	51 ^b	45 ^b
Doum gum	79 ^c	64 ^b	66 ^c	81 ^c	70 ^c	63 ^b	75 ^c
Doum cmc	56 ^b	59 ^b	51 ^b	51 ^b	63 ^b	58 ^b	56 ^b
Doumfilt	21 ^a	39 ^b	40 ^b	17 ^a	29 ^a	39 ^b	30 ^a

Sum of ranks having different superscript letter (s) in a column differ significantly ($P \leq 0.05$). [a \leq 38] [b = 38 – 64] [c \geq 64]

Microbial Assay of Doum Drinks:As illustrated in Table (3.3), the fresh traditional doum beverage showed low bacterial total viable count (TVC) of 1.8×10^3 cfu/ml. The total viable count was drastically reduced to 3.3×10^2 cfu/ml due to filtration. Preparation with distilled water has slightly increased the TVC of the doum drink to 2.9×10^3 cfu/ml. addition of CMC markedly elevated the TVC to 8.3×10^3 cfu/ml. The total viable count of bacteria was enormously raised to 17.6×10^3 cfu/ml owing to addition of gum Arabic. Interestingly, the five types of doum drinks were proved to be free contamination of yeast, mould and coli form bacteria. Also, the beverages were devoid from pathogenic bacteria (*Staphylococcus aureus* and *Salmonella*). The fresh baobab beverage was reported to have only negligible (10 cfu/ml) total viable count of bacteria (Abdalla *et al.*, 2010). However, gudeim juice was found to contain sequentially 3.82, 1.85 and 3.07 log₁₀ cf/ml total plate count (TPC), coli form and yeast and mold (Alrikain, 2004).

characteristics. Significant ($P \leq 0.05$) deterioration in color, taste, appearance, overall quality and precipitate formation was observed as a result of gum Arabic application compared to the traditional drink (control). Preparation of doum beverage using distilled water slightly improved color, appearance, overall quality and precipitate formation, but sparingly worsen aroma, taste and mouth feeling.

Conclusions and recommendations

Conclusions

All five products were examined for physicochemical, microbiological and organoleptic qualities.

- Beverage containing gum Arabic and CMC showed significantly ($P \leq 0.05$) lower pH values but higher acidity, TSS, viscosity and sugar.

- Filtration result in a doum beverage with significantly ($P \leq 0.05$) lower acidity, TSS, viscosity and significantly ($P \leq 0.05$) higher sugars.
- The five types of doum drinks were proved to be free from contamination of yeast, mould, coli form, *Staphylococcus aureus* and *Salmonella*.
- Filtered doum drink was confirmed to be the best product owing to its highly acceptable sensory characteristics. The product was also virtually free from precipitated pulp.

Recommendations

In view of the promising results of the present study it is recommended:

- The filtrated doum drink showed organoleptically acceptable qualities, therefore, development of such novel product should be encouraged.
- More studies on keeping quality, shelf life and packaging of the present product are needed.
- Substances responsible for precipitate formation in doum drinks require further investigation to reveal their nature.
- Much attention and scientific awareness should be devoted to traditional Sudanese foods and drinks, particularly those derived from doum fruit, in order to be utilized at industrial level.
- Many efforts should be directed to mechanically obtained doum slices

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