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USE OF SWEET SORGHUM SYRUP AS A REPLACEMENT OF SUCROSE IN SOME CANDIES AND SYRUPS

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ABSTRACT

In this investigation sucrose was replaced with different levels of sweet sorghum syrup in some products i.e. foulia and semsemia candies, strawberry and tamarind syrups.

The chemical composition of the processed semsemia was (on dry weight basis) : moisture ٣.٣٥ %,٣.٧٥ %, protein ١٦.٣٧ %, ١٨.٤١ %, fat ٣٩.٠٤ %, ٣٩.٤٩ %, nitrogen free extract ٤٢.٠٤ %, ٣٨, ٨٢ % ash ١.٨٠ %, ٢.٣٦ %, and fiber ٠.٧٤ %, ٠.٨٦ %, for control and ٥٠٪ sucrose replaced sample, respectively. Processed foulia contained : moisture ٣.٥٩ %, ٣.٧٥ %, protein ١٨.٦٣%, ١٩.٥٦ %, fat ٣٨.٨١ %, ٣٩.١٠ %, nitrogen free extract ٤٠.٥٢ %, ٣٨.٧٥ %, ash ١.٤٢ %, ١.٩٦%, and fiber ٠.٦٢ %, ٠.٦٣ %, for control and ٢٥٪ sucrose replaced sample, respectively.

The physical and chemical characteristics of processed tamarind and strawberry syrups were: TSS ٦٢.٢١٪, ٦١.٦٦٪, ٦٠.٠٠%, ٦١.٥٢٪, pH, ٢.٢٧, ٢.٢٩, ٢.٩٠, ٣.٠٥, moisture ٣٧.٣٣%, ٣٨.٤٦%, ٤٠.٠٠%, ٣٨.٥٠% and ash ٠.٤٨%, ٠.٤٤%, ٠.٢٤%, ٠.٣٦% for tamarind control, tamarind (٢٥٪SSS), strawberry control and strawberry (٢٥٪SSS) beverages, respectively (on wet weight basis). Semsemia and foulia samples contained SSS had lower TBA–values than control samples during storage. The lowest value of moisture content was recorded in semsemia samples at the end of storage period while foulia samples had the highest value. The panel test scores of processed semsemia and

foulia samples decreased with increasing the storage period from ٠ to ١٠٥ days. Sensory evaluation of candies indicated that replacement of sucrose by ٥٠٪ and ٢٥٪ of SSS were preferable for semsemia and foulia processing, respectively to obtain high quality grade. Sensory evaluation of tamarind beverage indicated that replacement of sucrose by ٢٥٪ of SSS produced tamarind beverage with excellent quality grade. Although the levels of replacement could be reached up to ٧٥٪ to produce good tamarind beverage. Sensory evaluation of strawberry beverage showed that replacement of sucrose by ٢٥٪ of SSS produced strawberry beverage with excellent quality grade .

It could be conceded that replacement of sucrose by ٢٥٪ of SSS led to produce, foulia, semsemia candy, tamarind and strawberry syrup . Replacement of sucrose by ٥٠٪ of SSS in semsemia resulting in excellent quality grade and better than the control .

INTRODUCTION

The great increase in sugar consumption in Egypt caused a gap between production and market demand. Consequently, there have been a great interest in finding a sugar substitute for certain uses in the food industry.

Sucrose plays a role as bulking and dispersing agent, preservative action, controlled reactivity in the browning reaction, flavor carriers fermentation substrate, texturizer, stabilizer and decorative function as a topping. Also sugars in solution exert an osmotic pressure, which manifests itself in a reducing water activity as the concentration of sugar rises (Salunkhe, *et al.* ١٩٦٣;Glicksman and Farkas, ١٩٦٦ ; Nicol ١٩٨٠ and GodShall, ١٩٩٠).

Sucrose Substitutes are used in the confectionery industry for several reasons, such as, costs, health and technological reasons (Fincke, ١٩٧٦). The market is calling for healthy food which means that new sugar substitutes will be needed with the ability to reduce carcinogenicity, suitability for diabetics, non- toxic nature and, above all, to reduce energy content to avoid promoting over weight (Bollinger, ١٩٨٧).

Sweeteners are the most important component of confectionery, they contribute functionalities in texture, product stability, microbial stability, flavor, color and overall appeal. The sweet compounds are classified to nutritive sweeteners and non–nutritive sweeteners, which were consumed as sugar substitutes in food. (Hyvonen ١٩٩٠). Therefore, different studies are now carried out to find other acceptable sweet substances, that are soluble, stable, non-carious, low in calories and non-toxic and not possess the side effects of sucrose (Krutosikora and Michel, ١٩٩٢) .

Ferweez (١٩٩٧) found that sweet sorghum could be a good substitution for sugar cane for the table syrup production because of their suitable physical, chemical and organolyptic characteristics compared to treacle (cane syrup).Sweet sorghum or sorgo [Sorghum bicolor var Saccharatum, Moench (L.) is grown in Egypt on a small scale as a summer forage crop and has a potential future for sugar production. Available information, however, is few on its cultural practices as a dualpurpose crop for sugar and forage.(Bekheet, et al. ٢٠٠٦). The sorghum syrup is made by processing squze from the stalks of certain types of sorghum called sweet sorghum. Seidl (١٩٩٢) reported that sorghum syrup could be an alternative raw material for malting and brewing industry and also as sweeteners for foods and beverages industry. It could be used in some products i.e in jam as substitute of sucrose at concentration ١٠ , ٢٠ , ٣٠,٤٠ and ٥٠٪ (Abbas, ٢٠٠٠) ; in cake at levels of ٢٥, ٥٠, ٧٥ and ١٠٠% (Souzan, et al, ٢٠٠٥) and in candy and caramel (Groves, ١٩٨٢) as it stabilizating these candies, by contributing to viscosity and inhabitating the crystal formation of sucrose.

Confectionery described spectrum of sweet goods and take a different meaning depending on the country in which it is used. In the United Kingdom the term applies to any sweet product including cakes (Minifie, ١٩٨٩). In the United States, confectionery is candy and includes two types: sugar confectionary and chocolate confectionary. EL-Khishin (١٩٧٢) reported that foulia had high nutritional, caloric values, sensation of satiety and has a chemical composition of moisture ٤.٤٩٪, protein ١٦.٨٧٪, fat ٣٢.١١٪ total carbohydrates ٤٠.٧٥٪,and ash ٢.١١٪.

On the other hand, consumption of beverages such as canned iced coffee, iced tea, and noncarbonated fruit beverages with exotic flavors such as mango and passion fruit are increasing. Ahmed, et al. (٢٠٠٧) reported that concentrated tamarind juice contained TSS of the paste was found to be ٧١° Brix while the pH ٢.١. The product contained ٥٨ % carbohydrate, ٢.٥ % protein and ٠.٦٥ % fat. Torreggiani, et al. (١٩٩٩) reported no significant change (P >٠.٠٥) in color of all juices, over the first ٤ months of storage. While after ٨ months there was a significant decrease (P≤٠.٠٥) . Hamed, et al. (١٩٧٤) reported that most of the carbonated beverage derive their characteristic aroma and flavor from synthetic organic derivatives which do not contribute much to the nutritive value of the product. Recently the tendency in manufacturing such beverages was to use natural concentrate juice to increase the nutritive value of the product .

Venkatesh, et al. (١٩٨٣ and ١٩٨٤) studied the effects of packaging materials and storage conditions on shelf-life and sensory properties of the product .They found that samples packaged in low density polyethylene (LDPE) showed some gradual change in sensory properties, and storage periods were ٤ months for high density polyethylene (HDPE), ٦ months LDPE laminate and ١٠ months for all cans. EL-Khishin (١٩٧٢) stored foulia sweet in polyethylene bags at room temperature for ٦ months and noted decrease in moisture content by about ٠.٨٤ %. When packed in carton boxes it showed approximately the same result as polyethylene bags.

The present investigation was carried out to study:١- the effect of replacement of sucrose with sweet sorghum syrup in some products i.e., traditional candies (foulia and semsemia) strawberry and tamarind beverages ٢- the chemical composition of raw materials and final products i.e., sweet sorghum syrup, peanut, sesame, strawberry, tamarind, foulia, semsemia, strawberry and tamarind beverages ٣- the effect of replacement of sucrose with different levels of sweet sorghum syrup on the quality characteristics of the produced, foulia, semsemia, tamarind and strawberry beverages and ٤- effect of storage on the quality of semsemia and foulia candy.

MATERIALS AND METHODS

Materials:

Sweet sorghum syrup: It was prepared from sweet sorghum (sorghum bicolor L. Moench); Honey cultivar , obtained from Mallawy Agric. Res.Station, Minia Governorate. as described by Abbas and Nour El-Hoda (٢٠٠٠) .

Foulia and semsemia ingredients: Peanut, seasem, sucrose and commercial glucose syrup were purchased from local market in Minia, Egypt.

Tamarind and strawberry beverages ingredients: Strawberry samples and tamarind (*Tamarindus indica*) were obtained from local market, while citric acid and sodium benzoate of analytical grade were obtained from Sigma Co.

Processing of Foulia and Semsemia candies: Table ١ shows the formula of control and sugar replaced foulia and semsemia candies. Sugar was added to a minimal quantity of water, and dissolved by stirring and boiling. Glucose Syrup was added to the sugar solution and the mixture was stirred vigorously at ١١٥°C to obtain a viscous mixture suitable for the addition of peanuts (at density about ١.٤٣٥٢ gm/cm٣)(Hemmat et al., ١٩٩٧). The mixture left to cool to about ٥٠°C and the mixture was stirred thoroughly till homogenized. The mixture was flatted on alabaster table by a roller (١.٥ cm) and cut, (using metallic frames) into brick's, each with dimensions of ١٤X ٦.٥ X١.٥ cm., and about ٢٤٠ g in weight.

Preparation of Tamarind and Strawberry syrups: Tables ٢, and ٣ illustrate the formulation of control and sugar replaced strawberry and tamarind syrups. Strawberry was washed and trimmed, then put in an alternately layers with sugar in a china and left in a refrigerator for ٢٤ hours. Citric acid was added (٣gm./١kg.sugar), and turned over until the sugar was dissolved in order to crush the fruit. The mixture was strained using a clean dressing and boiled with a continuous turning over for ١٥ minutes till the T. S. S. reached ٦٠٪ after adding sodium benzoate. Froth was removed during boiling and sterilized bottles were used to package the syrups.

Table ١: Formula of Foulia or Semsemia candies prepared with sucrose and different levels of sorghum syrup as sucrose substitutes (gm).

Ingredients (gm) / Treatments	Control	A	B	C	D
Roasted peanut or Roasted sesame	١٠٠.٠٠	١٠٠.٠٠	١٠٠.٠٠	١٠٠.٠٠	١٠٠.٠٠
Sucrose	٥٠.٠٠	٣٧.٥٠٠	٢٥.٠٠	١٢.٥٠	-
Sweet Sorghum Syrup	-	١٦.٦٠	٣٣.٢٠	٤٩.٨٠	٦٦.٤٠
Commercial Glucose Syrup	٤٠.٠٠	٤٠.٠٠	٤٠.٠٠	٤٠.٠٠	٤٠.٠٠
Water cm٣	٥٠.٠٠	٤٥.٨٥	٤١.٧٠	٣٧.٥٥	٣٣.٤٠

The replacement percent was calculated on T.S.S of Sweet Sorghum Syrup (Abbas ٢٠٠٠)

A: Replacement of ٢٥ % Sucrose by Sweet Sorghum Syrup (SSS). **B**: Replacement of ٥٠ % Sucrose by (SS S).

C: Replacement of ٧٥ % Sucrose by (SSS)&**D**: Replacement of ١٠٠ % Sucrose by (SSS).

Table ٢: Formulas of Strawberry syrup prepared with sucrose and different levels of sorghum syrup as sucrose substitutes (gm).

Ingredients gm. / Treatments	Control	A	B
Strawberry	٢٠٠	٢٠٠	٢٠٠
Sugar	٢٥٠	١٨٧.٥	١٢٥
Sweet Sorghum Syrup	-	٨٣	١٦٦
Citric acid	٠.٧٥	٠.٥٦	٠.٣٧٥
Sodium benzoate	٠.٤٥	٠.٤٥	٠.٤٥

A: Replacement of ٢٥ % Sucrose by Sweet Sorghum Syrup (S.S.S).
B: Replacement of ٥٠ % Sucrose by (S.S.S).

Preparation of candy for storage: Control and sucrose replaced products (candy**)** were packaged in a commercial packaging material low density polyethylene. The sample bags heat-sealed and stored under accelerated condition (٣٠˚ C and ٨٠٪ RH) for ١٦ weeks, by using a saturated solution of ammonium sulfate (ASTM, ١٩٧١).

Table ٣: Formulas of tamarind syrup prepared with sucrose and different Levels of sweet sorghum syrup as sucrose substitutes (gm).

Ingredients (gm.) \ Treatment	Control	A	B	C	D
Tamarind	٢٥	٢٥	٢٥	٢٥	٢٥
Sugar	٢٣٧.٥	١٧٨.١٢٥	١١٨.٧٥	٥٩.٣٧٥	-
Sweet Sorghum Syrup	-	٧٨.٨	١٥٧.٦	٢٣٦.٤	١١٥.٤
Water cm٣.	١٩٠	١٧٠.٣	١٥٠.٦	١٣١	١١١.١٢٧
Citric acid	٠.٧١٢٥	٠.٥٣٤	٠.٣٥٦	٠.١٧٨	-
Sodium benzoate	٠.٢٦	٠.٢٦	٠.٢٦	٠.٢٦	٠.٢٦

A: Replacement of ٢٥ % Sucrose by Sweet Sorghum Syrup (SSS).
B: Replacement of ٥٠ % Sucrose by (SSS). C: Replacement of ٧٥ % Sucrose by (SSS).
D: Replacement of ١٠٠ % Sucrose by (SSS).

Methods:

Physical Characteristics: Total soluble solids content (TSS%) was determined by Abbe Refract meter standardized at ٢٠ ˚ C as described in Plews (١٩٧٠).

Refractive index (R.I): It was estimated by abbe Refractometer at ٢٠ ˚ C as described in **A**.O.A.C (١٩٩٥).

pH value was measured by Backman pH meter on a mixture of ١٠ ml syrup and ٢٠ ml distilled water according to Collins et.al. (١٩٧٧).

Surface color value was determined by the color Wesson method using lovibond glasses calibrated in accordance with Gillet (١٩٦٠).

Color index of sweet sorghum syrup (SSS): was determined using Lange colorimeter (Lp&W) according to Schneider (١٩٧٩)

Apparent purity: was calculated according to Taha *et al* (١٩٩٤) by using the following equation. $\text{Apparent purity\%} = \frac{\text{Sucrose\%}}{T.S.S\%} \times 100$

Non-sucrose substances percentage (NSS %): was calculated according to EL-Syiad, (١٩٩٠**),** using the following formula: Non-sucrose substances % (NSS %) = T. S. S % - sucrose %

Chemical Analysis: Moisture , total solids (TS), sucrose, reducing sugars, starch, total nitrogen and ash content were determined according to A.O.A.C (١٩٩٥).

Titratable acidity: (TA**)** was determend according to Chen and Picou (١٩٧٢).

Total sugars content: Total sugars content was determend as described in, E.O.S.Q.C. (١٩٧١), and total sugar were determined as reducing sugar.

Total lipids content were determined according to the method described by Smith and Reeve (١٩٨١).

TBA-reactive substances were measured using the method of Harold *et al.,* (١٩٨١).

Sensory evaluation: Color, texture, taste, odor, and overall acceptability were made in order

to determine consumer acceptability. (Larmond, ١٩٧٧). The data were analyzed statistically using Duncan's new multiple range test (Steel and Torrie, ١٩٨٠).

Statistical analysis: The data were subjected to statistical analysis using Duncan's multiple range test according to Snedecor & Cochran. (١٩٦٧**).**

RESULTS AND DISCUSSION

Physical properties and chemical constituents of sweet sorghum syrup:

Data shown in Table ٤ show that sweet sorghum syrup contained total solids was ٧٥.٤٩ %(WWB) and this fraction include ٧٥.٢٤٪ soluble solids (TSS%) plus ٠.٢٥٪ insoluble solids, ٦٨.٤٧٪(WWB) total sugars,٣٦.١٢٪, ٣٢.٠٤٪, and ٠.٤٤ %, sucrose, reducing sugars and starch respectively. Ash content was ٣.٨٣٪, while protein content was ٢.٨٥٪. Titratable acidity, refractive index (RI), color index, pH and purity % were ١٧٥, ١.٤٣٣٣, ٦٩.٠٠, ٥.١٠ and ٥١.٠٦, respectively. These indicated that color index was high. The darkness of the syrup could be attributed to the melanodene and the browning components formed during syrup processing. Color is one of the primary quality indicators by which the consumer evaluate natural and processed food, what limited the substitution ratios of sucrose by sorghum syrup as shown in the organolyptic properties obtained. Data showed also that the purity of syrup was low due to the high reducing sugar content, which affected the sweetness degree of the syrup and the products. These results are in agreement with those obtained by Collins, *et al*. (١٩٧٧), Ferweez (١٩٩٧), Abbas and Nour El-Hoda (٢٠٠٠).

Table ٤: Physical properties and chemical composition of sweet sorghum syrup

Properties*	Wet weight basis (g) (WWB)	Dry weight basis (g)(DWB)
Total soluble solids (T.S.S)	٧٥.٢٤	-
Refractive index (R.I)	١.٤٣٣٣	-
Color Index	٦٩.٠٠	-
pH	٥.١٠	-
Purity%	٥١.٠٦	-
Moisture%	٢٤.٥١	-
Total Solids (T.S)%	٧٥.٤٩	-
Sucrose%	٣٦.١٢	٤٨.٠٠
Reducing sugars (R.S)%	٣٢.٠٤	٤٢.٢٠
Total Sugars%	٦٨.٤٧	٩١.٠٠
Starch%	٠.٤٤	٠.٧٨
Crude protein%	٢.٨٥	٣.٧٨
Titratable acidity**	١٧٥	-
Ash%	٣.٨٣	٥.٠٩

*Mean of three replicates. **ml ٠.١ N NaoH/ ١٠٠ ml syrup

Chemical composition of sesame and peanut

Table ٥ shows the chemical composition of sesame and pesnut. Sesame had moisture content of ١.٤٨٪, while peanut sample moisture content ٢.١٨٪ . Protein content was ٢٥.٠٣ and ٢٦ .٣٥ % (DWB) for, sesame and peanut, respectively. Fat content was ٥٤.١٣ and ٥٣.٥٨% for sesame and peanut on dry weight basis respectively. Nitrogen free extract content was ١٥.٢٤ and ١٥.٩٧% , while crude fiber was ٢.٥٤% and ١.٥٥٪ and ash content was ٣.٠ and ٢.٥٠٪ for Sesame and pea- nut, (dry weight basis) respectively. These results are agree with those obtained by El-Sayed (١٩٩٠) and El-Adawy (١٩٩٢) .

Table ٥: Chemical composition of studied raw materials:-

Component%	*Sesame*		*Peanut*	
	Wet weight basis (g)	Dry weight basis (g)	wet weight basis (g)	Dry weight basis (g)
Moisture	١.٤٨	-	٢.١٨	-
Crude protein	٢٤.٦٦	٢٥.٠٣	٢٥.٧٨	٢٦.٣٥
Crude fat	٥٣.٣٣	٥٤.١٣	٥٢.٤١	٥٣.٥٨
Nitrogen free extract	١٥.٠٢	١٥.٢٤	١٥.٦٢	١٥.٩٧
Crude fiber	٢.٥٠	٢.٥٤	١.٥٢	١.٥٥
Ash	٣.٠٠	٣.٠٥	٢.٥٠	٢.٥٦

*Mean of three replicates.

Sensory evaluation of prepared semsemia:

Fig. ١ shows the sensory evaluation of prepared semsemia samples contained Sweet sorghum syrup as sweetener substitute for sucrose. A insignificant variations (p≤ ٠.٠٥) was observed between the control and B (٥٠٪ sorghum syrup) samples in all studied parameters, while the other samples were significantly different. It was clear from the results that control and (B) samples had the higher values than the other samples (A, C and D) for all determined characteristics. So, the B samples, where ٥٠٪ of sucrose substituted with sorghum syrup, were preferable for semsemia processing.

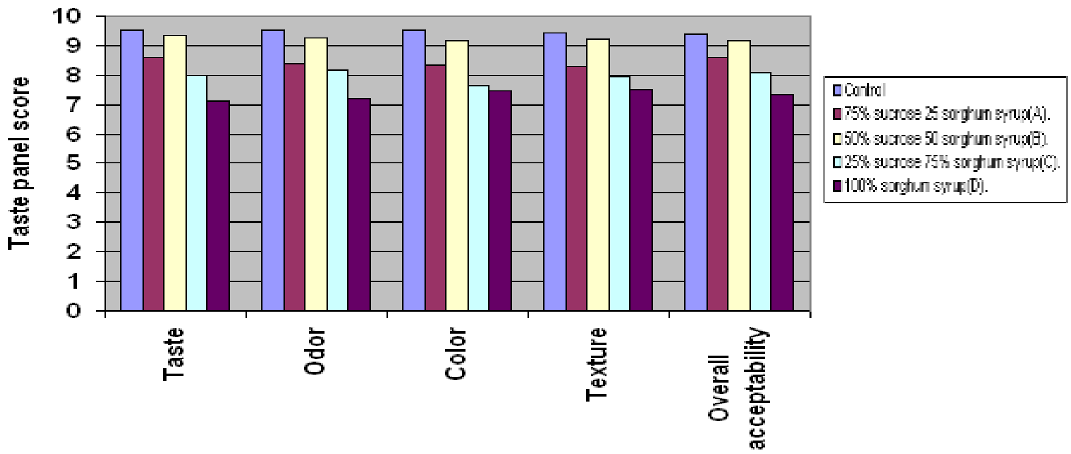

Fig. ١: Sensory characteristics of semsemia candy prepared by replacement of sucrose with different levels of sweet

Sensory evaluation of prepared foulia:

Fig. ٢ indicates that only (A) samples (٢٥٪ Sweet sorghum syrup) had insignificant differences with control samples for all sensory parameters .Other samples (B, C, D) had lower values than control samples. Increasing the substitution level, the sensory evaluation scores decreased according to the panelists respond.

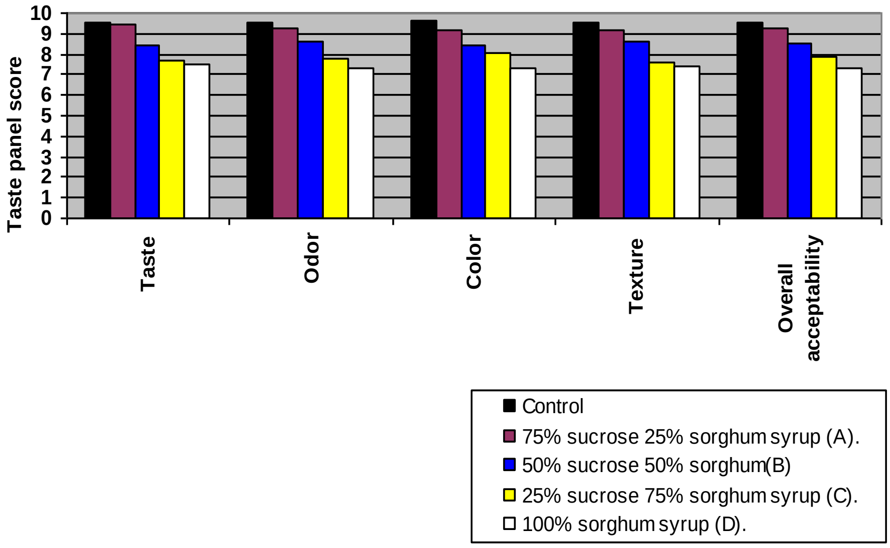

Fig ٢: Sensory characteristics of foulia candy as affected by replacement of sucrose with different levels of sweet sorghum syrup

Sensory evaluation of prepared tamarind beverage:

Fig. ٣ shows the average sensory evaluation scores given for taste, odor, color, texture and overall acceptability of freshly prepared tamarind beverage samples at different sweet sorghum syrup concentrations (٠,٢٥, ٥٠,٧٥ and ١٠٠٪). The data indicated gradual decreasing in all studied characteristics score with increasing the level of SSS . No significant differences (p≤ ٠.٠٥) were observed between A and control samples. Panel test showed the possibility of using sweet sorghum syrup as partial (sucrose) substitute sweetener in ratio of ٢٥٪ (A sample) without significant effect on sensory attributes of the tamarind beverage produced.

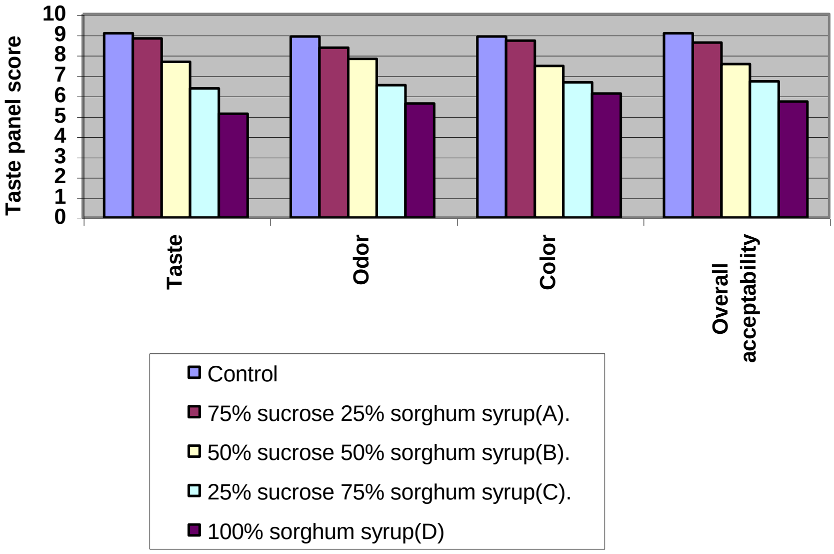

Fig. ٣: Sensory characteristics of tamarind beverage by replacement of sucrose with different levels of SSS

Sensory evaluation of prepared strawberry beverage. For the preparation of strawberry beverage, only ٢٥٪ and ٥٠٪ substitution levels of sucrose by sweet sorghum syrup were used. These ratios were determined by preliminary trails, which indicated that using higher sorghum syrup ratios resulted in a dark, lower taste quality beverage. Fig. ٤ shows that all values of quality parameters greatly affected (decreased) with increasing the substitution ratio from ٢٥ to ٥٠٪, however there were no significant differences (P ≤ ٠.٠٥) between control and A (٢٥٪ substitution level) samples. This means that the use of sorghum syrup (SS) as sucrose substitute in strawberry beverage affected quality attributes more than the other products. The results also showed that sorghum syrup (SS) as sucrose substitute sweetener could be used in ratio of ٢٥٪ for, foulia, tamarind and strawberry beverages while it could be used in ratio of ٥٠٪ in semsemia candy without significant effect of studied sensory attributes.

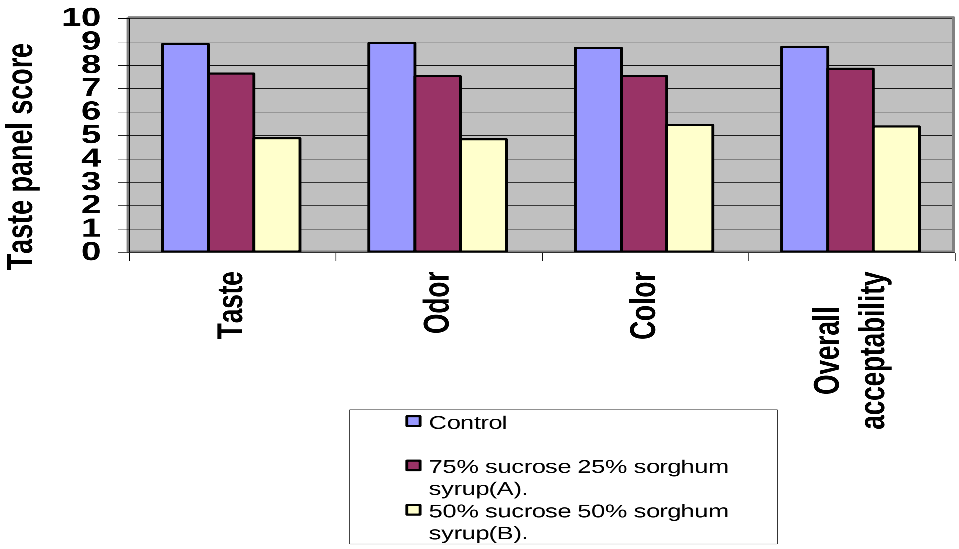

Fig ٤: Sensory characteristics of strawberry beverage as affected by replacement of sucrose with different levels of sweet sorghum syrup

Chemical composition of prepared semsemia:

Table (٦) presents the chemical composition of the prepared semsemia, it was as follows: moisture ٣.٣٥, ٣.٧٥٪, crude protein ١٦.٣٧, ١٨.٤١٪; crude fat ٣٩.٠٤, ٣٩.٤٩٪; nitrogen free extract ٤٢.٠٤, ٣٨.٨٢٪, Ash ١.٨٠, ٢.٣٦٪; crude fiber ٠.٧٤, ٠.٨٦٪(of DWB) for control and B (٥٠٪ SSS), samples respectively. It could be noticed that sample B contained slightly higher values of moisture, protein, fat, ash and fiber contents than control samples, while had lower carbohydrate content. This was might be due to the higher contents of sweet sorghum syrup from moisture, protein, fat, ash and fiber and lower carbohydrate content than sucrose. These results are in good agreement with those found by Honig (١٩٦٠), and El-Adawy (١٩٩٢)

Table ٦: Effect of sorghum syrup replacement on the chemical composition of semsemia:

Constituents%	Control		Replacement of ٥٠ % Sucrose by S.S.S (B)	
	Wet weight basis (g)	Dry weight basis (g)	Wet weight basis (g)	Dry weight basis (g)
Moisture	٣.٣٥	-	٣.٧٥	-
Crude protein	١٥.٨٢	١٦.٣٧	١٧.٧٢	١٨.٤١
Crude fat	٣٧.٧٣	٣٩.٠٤	٣٨.٠١	٣٩.٤٩
Nitrogen free extract	٤٠. ٦٣	٤٢.٠٤	٣٧.٣٧	٣٨.٨٢
Ash	١.٧٤	١.٨٠	٢.٢٧	٢.٣٦
Crude fiber	٠.٧٢	٠.٧٤	٠.٨٣	٠.٨٦

*Mean of three replicates

Chemical composition of prepared foulia:

The effect of sucrose substitution at the level of (٢٥٪SSS) on the chemical composition of foulia candy is shown in Table ٧. The data showed the same trend as semsemia candy where moisture, protein, fat, ash and fiber were slightly increased while total carbohydrate was decreased.

Table ٧: Effect of sweet sorghum syrup replacement on the chemical composition of foulia.

Constituents%	Control		Replacement of ٢٥ % Sucrose by S.S.S (A)	
	Wet weight basis (g)	Dry weight basis (g)	Wet weight basis (g)	Dry weight basis (g)
Moisture	٣.٥٩	-	٣.٧٥	-
Crude protein	١٧.٩٦	١٨.٦٣	١٨.٨٣	١٩.٥٦
Crude fat	٣٧.٤١	٣٨.٨١	٣٧.٦٣	٣٩.١٠
Nitrogen free extract	٣٩.٠٦	٤٠.٥٢	٣٧.٢٩	٣٨.٧٥
Ash	١.٣٧	١.٤٢	١.٨٩	١.٩٦
Crude fiber	٠.٦٠	٠.٦٢	٠.٦١	٠.٦٣

*Mean of three replicates.

The replacement of ٢٥٪ sugar with the equivalent quantity of (SSS) led to slight increase in the moisture content from ٣.٥٩ to

٣.٧٥٪, protein from ١٨.٦٣ to ١٩.٥٦٪, fat from ٣٨.٨١ to ٣٩.٠١٪, ash from ١.٤٢ to ١.٩٦٪ and fiber content from o.٦٢ to ٠.٦٣٪ and nitrogen free extract content decreased from ٤٠.٥٢ to ٣٨.٧٥٪ (on DWB). These differences might be princeply due to the differences in the chemical composition between sucrose and sorghum syrup (Waller and Duncan ١٩٦٩, El-sayed ١٩٩٠, and Abbas ٢٠٠٠).

Physical and chemical characteristics of prepared tamarind and strawberry:

Table ٨ presents the physical properties, total soluble solids (TSS), pH , moisture, and ash contents for control and sugar tamarind and strawberry syrups. The data show slight decrease in T.S.S for tamarind syrup (from٦٢.٢١ to٦١.٦٦٪) and slight increase in strawberry syrup (from ٦٠.٠٠ to ٦١.٥٢٪). The pH value showed almost no change, while moisture content increased slightly from ٣٧.٣٣, to ٣٨.٤٦٪ for tamarind syrup, but decreased from ٤٠.٠٠ to ٣٨.٥٠٪ for strawberry syrup. Ash content of tamarind was decreased from ٠.٤٨ to ٠.٤٤٪, while it increased from ٠.٢٤ to ٠.٣٦٪ for strawberry syrups. This is might be due to the higher ash content of SSS and tamarind fruit than sugar (Abbas ٢٠٠٠).

Table ٨: Effect of sweet sorghum syrup as sucrose substitute on some physical and chemical characteristics of strawberry and tamarind syrups on wet weight basis.

Samples / Determination	Strawberry syrup		Tamarind syrup	
	Control	(A)	Control	(A)
T.S.S%	٦٠.٠٠	٦١.٥٢	٦٢.٢١	٦١.٦٦
PH	٢.٩	٣.٠٥	٢.٢٧	٢.٢٩
Moisture%	٤٠.٠٠	٣٨.٥٠	٣٧.٣٣	٣٨.٤٦
Ash %	٠.٢٤	٠.٣٦	٠.٤٨	٠.٤٤

A: Replacement of ٢٥ % Sucrose by Sweet Sorghum Syrup.
*Mean of three replicates.

Color of prepared candies and syrups:

Color was measured using Hunter lab and color difference meter then the chromaticity was defined by dimension “L”, “a” and “b” values. Results in Table ٩ indicate that Hunter positive “a” value, (which indicate redness) showed differences between control and samples in all prepared samples. The "a" value was increased for semsemia, tamarind and strawberry beverage while it decreased for foulia samples. The highest increase in "a" value was found for tamarind (from ١٤.٨٣ to ٢٨.٤٣.) and the lowest increase was recorded in strawberry (from ٣٥.١٦ to ٣٦.٨٦). While Hunter positive "b" value, which indicate yellowness, reported an increase for all prepared products; contained sorghum syrup. The increment was high for foulia and strawberry beverage followed by tamarind then semsemia (see table(٩). As for positive "L" value, which indicated white lightness; decreased for all samples except foulia. Generally, loss of natural red color of anthocyanin and other red color rich pigments is caused by the presence of certain metallic cations, enzymes, oxygen, ascorbic acid, and high temperatures used in processing (Shewfelt, ١٩٧٥). The changes in the color could also be caused by the browning or Millard reaction between amino acids and monosaccharides or other organic acid or phosphate. Such browning components or melanodens pigments were formed in sweet sorghum syrup during processing and could affect the color of the prepared products as concluded from Table ٩.

Table ٩: Effect of sweet sorghum syrup replacement on color of candies and syrups.

Product	L	a	b
Semsemia control	٤٨.٣٦	١٣.٨٦	١٦.٤٨
Semsemia (٥٠٪ sucrose replacement)	٣٥.٧١	١٥.٥٣	١٦.٩٥
Foulia control	٣٩.٣٣	٣٦.٣٤	١٩.١٢
Foulia (٢٥٪ sucrose replacement)	٤٤.٩٥	٢٨.٨١	٣٨.٥٤
Tamarind control	٣١.٠٣	١٤.٨٣	١٤.٧٣
Tamarind (٢٥٪ sucrose replacement)	١٤.٤٥	٢٨.٤٣	١٩.٨٧
Strawberry	٤٦.٦٣.	٣٥.١٦	٢٤.٤٢
Strawberry (٢٥٪ sucrose replacement)	٢١.٢٧	٣٦.٨٦	٤١.٠٩

Effect of storage on some quality parameters of the prepared products:

Data presented in Table ١٠ Show a gradual increase in the TBA-value during storage for all samples. The rate of increase depending on the storage period as well as candy type. Semsemia samples, the TBA-value was increased from ١.٩٣ for fresh control sample to ٧.٨٨ mg thiobarbituric acid/١٠٠ g sample after ١٢٠ days of storage.

Table ١٠: The effect of storage on TBA of prepared candy (mg malonaldehyde /١٠٠ sample on wet weight basis).

Product / Storage period(days)	Semsemia		Foulia	
	Control	**(B)**	**Control**	**(A)**
٠	١.٩٣	٠.٦٧	٠.٦٨	٠.٦٢
١٥	٣.١٤	٠.٧٠	٠.٧٢	٠.٦٤
٣٠	٤.٣٤	٠.٧٧	٠.٧٩	٠.٧٥
٤٥	٥.٢٧	٠.٧٩	١.٩٥	١.١٣
٦٠	٥.٣٨	٠.٩٦	١.٤١	١.٣٦
٧٥	٦.٤٧	٢.٠٦	٣.٠٣	١.٩٢
٩٠	٦.٨١	٢.٢٦	٣.٤٦	٢.٥٧
١٠٥	٧.٥١	٤.٤١	٤.٠١	٣.٤٣
١٢٠	٧.٨٨	٥.٤١	٤.٦٩	٤.١٧

(A): Replacement of ٢٥ % Sucrose by Sweet Sorghum Syrup (SSS).
(B): Replacement of ٥٠ % Sucrose by SS.

Semsemia samples contained (SSS) had a lower TBA–value (٠.٦٧) at zero time of storage period and increased to ٥.٤١ mg TBA (١٠٠g sample) at the end of storage period. TBA–value of foulia was lower than that of semsemia where it ranged from ٠.٦٨ to ٤.٦٩ mg thiobarbituric acid/١٠٠g samples for control and from ٠.٦٢ to ٤.١٧ mg thiobarbituric acid/١٠٠ g sample for the sample contained (S.S.S). It was clear from data that the TBA–values were much higher for control than the samples contained (SSS), especially for semsemia candy.

Effect of storage on moisture content of candy samples:

Table ١١ shows moisture content of semsemia and foulia samples. Moisture content increased from ٣.٨٠ to ٧.٩٣٪and from ٣.٧٥ to ٨.٩٩٪ for semsemia and foulia during storage period of ١٢٠ days.The moisture content of the samples at the end of storage period was the highest in foulia samples than semsemia samples. The moisture content of control samples in all prepared products was almost equal and was lower than that of the samples contained sorghum syrup (SS). The data indicated that prepared products absorbed high quantity of moisture (about ١٠٠٪ of original moisture content) during storage. This explain the importance of the packaging of such products to prevent undesirable changes.

Table ١١: Effect of storage on moisture*content of prepared candy.

Product / Storage period (days)	Semsemia		Foulia	
	Control	B	Control	A
٠	٣.٣٠	٣.٨٠	٣.٥٤	٣.٧٥
١٥	٣.٤٦	٣.٨٦	٣.٥٩	٣.٨٨
٣٠	٣.٦٣	٤.٣٤	٣.٦٢	٤.٣٢
٤٥	٣.٧٢	٥.١٧	٤.٠٢	٤.٤٥
٦٠	٣.٨٨	٥.٧٧	٤.١٥	٤.٨٢
٧٥	٤.٤٦	٥.٧٨	٤.٦١	٤٠٩٢
٩٠	٤.٦٤	٦.٦٥	٥.٨٨	٦.٠٦
١٠٥	٥.٩٧	٧.٧٩	٦.٤١	٨.٠١
١٢٠	٦.١١	٧.٩٣	٦.٨١	٨.٩٩

A: Replacement of ٢٥ % Sucrose by Sweet Sorghum Syrup (S.S.S). **B**: Replacement of ٥٠ % Sucrose by S.S.S
*Mean of three replicates.

Effect of storage on the sensory attributes of prepared semsemia samples:

Data in Table ١٢ panel test values of prepared semsemia samples during storage. All studied characteristics values were decreased with proceeding of storage period from ٠ to ١٠٥ days. Overall acceptability was affected (١٥ days) than odor and texture (٣٠ days). Taste and color had no significant (p ≤ ٠.٠٥) changes after ٦٠ days for all studied semsemia samples. The panel test scores were greatly decreased after ٧٥ day of storage.

Effect of storage on the sensory attributes of prepared foulia samples:

Results in Table ١٣ reveal significant differences (p ≤ ٠.٠٥) due to storage for all studied sensory attributes of the prepared foulia. Taste and texture showed significant decreases (p ≤ ٠.٠٥) after ٤٥ days of storage, while odor and color showed no significant decreases (p ≤ ٠.٠٥) after ٦٠ and ٧٥ storage days, respectively. It was noticeable from the storage data of all prepared products that the shelf life were about ٢-٣ months only. This might be due to the very extreme storage conditions especially the high relative humidity (٣٠˚C and ٨٠ RH). It could be concluded from results of this study that sweet sorghum syrup could be partially substituted sucrose in the studied products. More studies is needed for improvement of sweet sorghum syrup quality and consequently develop new products with bitter quality characteristics.

Table ١٢: Effect of storage on the sensory attributes of semsemia samples

Characteristics / Storage period days	Taste		Odor		Color		Texture		Overall acceptability	
	C	B	C	B	C	B	C	B	C	B
٠	٩.٣^{ab}	٩.٣^{ab}	٩.٣^{ab}	٩.٤^{a}	٩.١^{ab}	٩.٢^{a}	٩.٢a	٩.٢^{a}	٩.٦^{a}	٩.٦^{a}
١٥	٩^{abc}	٩^{abc}	٩^{ab}	٩^{abc}	٩^{ab}	٩^{ab}	٨.٨ab	٩.٢^{a}	٩.٢^{ab}	٩.٤^{a}
٣٠	٨.٦^{abcd}	٨.٧^{abcd}	٨.٦^{bcde}	٨.٨^{abcd}	٨.٨ab	٩^{ab}	٨.٤^{abc}	٨.٦^{ab}	٨.٧^{bcd}	٩.١^{abc}
٤٥	٨.٤^{abcd}	٨.٦^{abcd}	٨.٢^{de}	٨.٣^{cde}	٨.٨^{ab}	٨.٨^{ab}	٨.٢^{bc}	٨.٣^{bc}	٨.٦^{cd}	٨.٧^{bcd}
٦٠	٨.٢^{bcd}	٨.٢^{bcd}	٨.١^{de}	٨.١^{de}	٨.٦^{abc}	٨.٦^{abc}	٨.٢bc	٨.٢^{bc}	٨.١^{ef}	٨.٥^{de}
٧٥	٧.٧^{d}	٨^{cd}	٨^{e}	٨^{e}	٨^{c}	٨.٤^{bc}	٧.٧c	٧.٧^{c}	٧.٩^{f}	٨^{f}
٩٠	٥.٤^{e}	٦.^{e}	٥.٦^{g}	٦.٣^{f}	٥.٧^{e}	٦.٧^{d}	٥.٦e	٦.٤^{d}	٥.٧^{h}	٦.٤^{g}
١٠٥	٢.٥^{g}	٣.٦^{f}	٢.٢^{f}	٣.٢^{h}	٥^{f}	٥.٧^{e}	٢.٥^{g}	٣.٥^{f}	٢.٧^{j}	٣.٥^{i}

B = ٥٠٪ ss as substitute of sucrose on sample   C = control sample

Table ١٣: Effect of storage on the sensory attributes of foulia samples:

Characteristics / Storage period	Taste		*Odor*		*Color*		*Texture*		Overall acceptability	
	C	A	C	A	C	A	C	A	C	A
٠	٩.٢^{ab}	٩.٦^{ab}	٨.٨^{b}	٩.٨^{ab}	٨.٨^{a}	٨.٨a	٨.٨^{ab}	٩.٢^{a}	٩.٣^{ab}	٩.٤^{a}
١٥	٨.٨^{abcd}	٩.١^{abc}	٨.٧^{b}	٨.٨^{b}	٨.٧^{a}	٨.٨a	٨.٥^{ab}c	٨.٦^{abc}	٨.٨^{abcd}	٨.٩^{abc}
٣٠	٨.٧^{bcd}	٨.٨^{abcd}	٨.٥^{b}	٨.٦^{b}	٨.٣^{a}	٨.٧a	٨.٤^{abcd}	٨.٤^{abcd}	٨.٦^{bcde}	٨.٨^{abcd}
٤٥	٨.٦^{bcde}	٨.٧^{bcd}	٨.٢^{bc}	٨.٥^{b}	٨.١^{a}	٨.٢a	٨.٢^{bcd}	٨.٢^{bcd}	٨.١^{def}	٨.٢^{cde}
٦٠	٨.٢^{cde}	٨.٢^{cde}	٨b^{c}	٨.١^{bc}	٧.٩^{a}	٨.١a	٧.٨^{cde}	٨.١^{bcd}	٨.١^{def}	٨.١^{def}
٧٥	٧.٨^{e}	٧.٩^{de}	٧.٣^{cd}	٧.٤^{cd}	٧.٨^{a}	٧.٨a	٧.٣^{e}	٧.٦^{de}	٧.٤^{f}	٨^{ef}
٩٠	٦.١^{f}	٦.٢^{f}	٦.١^{e}	٦.٨^{de}	٦.٢^{b}	٦.٢b	٥.٩^{f}	٦.١^{f}	٦^{g}	٦.٥^{g}
١٠٥	٢^{g}	٢.٥^{g}	٢^{f}	٢.٧^{f}	٥.٤^{b}	٥.٦b	٢.٨^{g}	٣^{g}	٣.٢^{i}	٣.١^{h}

A= ٢٥٪ ss as substitute of sucrose on sample   C= Control sample

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استخدام شراب الذرة السكرية كبديل للسكروز في بعض الحلوى والشراب

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فى هذا البحث تم استبدال السكروز بمستويات مختلفة من شراب الذرة السكرية فى بعض المنتجات مثل حلوى الفولية والسمسمية وشراب الفراولة والتمرهندى. كان التركيب الكيميائي للسمسمية المصنعة(على أساس الوزن الجاف) كالتالي نسبة الرطوبة ٣.٣٥% ، ٣.٧٥% ، و البروتين ١٦.٣٧% ، ١٨.٤١% و الدهن. ٣٩,٠٤%و ٣٩.٤٩% والمستخلص الخالى من النيتروجين ٤٢.٠٤% ، ٣٨.٨٢% والرماد ١.٨٠% ، ٢.٣٦ والألياف.٠,٧٤%و ٠,٨٦% لكل من الكنترول والسمسمية المصنعة باستبدال ٥٠% سكروز على التوالى وكان التركيب الكيميائي للفولية المصنعة كالآتي :الرطوبة ٣.٥٩% ، ٣.٧٥% ، البروتين ١٨.٦٣% ، ١٩.٥٦% و الدهن ٣٨.٨١% ، ٣٩,١والمستخلص الخالى من النيتروجين ٤٠.٥٢% ، ٣٨.٧٥% والرماد ١.٤٢% ، ١.٩٦% والألياف ٠.٦٢% ، ٠.٦٣% للكنترول والعينة المستبدلة بنسبة ٢٥% سكروزعلى التوالى الخواص الفيزيائية والكيميائية لشراب التمر هندي وشراب الفراولة كالآتيTSS ٦٢.٢١ % و ٦١.٦٦% و ٦٠.٠٠%و ٦١.٥٢% وpH ٢.٢٧ و ٢.٢٩ و ٢.٩ و ٣.٠٥ و الرطوبة ٣٧.٣٣ % و ٣٨.٤٦% و ٤٠%و٥٠ ,٣٨. ٥% والرماد ٠.٤٨% و ٠.٤٤% و ٠.٢٤% و٠.٣٦% لعينات كنترول شراب التمرهندى وشراب التمرهندى المستبدل (٢٥% شراب ذرة سكرية) و كنترول شراب الفراولة وشراب الفراولة (٢٥% شراب ذرة سكرية) على التوالى (على اساس الوزن الرطب) .أظهرت عينات السمسمية والفولية المحتوية على شراب ذرة سكرية قيم أقل لحمض الثيوباربتيوريك مقارنة بعينات الكنترول أثناء التخزين. أظهرت النتائج ان أقل محتوى رطوبة كان لعينات السمسمية في نهاية فترة التخزين في عينات بينما سجلت عينات الفولية أعلي القيم . اظهرت ايضا الاختبارات الحسية في عينات السمسمية والفولية المصنعة بأنها تتناقص مع زيادة فترة التخزين من صفر الى ١٠٥ يوم.واشار التقييم الحسى ان الاستبدال بـ٥٠% و٢٥% شراب ذرة سكرية كان مفضلا للسمسمية والفولية المصنعة على التوالى للحصول على درجة جودة عالية . واشار التقييم الحسى لشراب التمر هندى ان استبدال السكروز بـ٢٥% شراب ذرة سكرية يؤدى الى انتاج شراب ذو درجة جودة ممتازة بالرغم من ان مستويات الاستبدال يمكن ان تصل الى٧٥% منتجة شراب تمر هندى جيد وبين التقييم الحسى لشراب الفراولة ان ا ستبدال السكروز بـ٢٥% شراب ذرة سكرية يؤدى لانتاج شراب ذو جودة عالية . ونستخلص من هذه الدراسة أن استبدال السكروز بـ ٢٥% شراب الذرة السكرية يؤدى الى انتاج حلوى الفولية و السمسميةو شراب التمر هندى و الفراولة . استبدال السكروز بـ ٥٠% شراب الذرة السكرية ادى لانتاج لسمسمية ذات جودة ممتازة وأفضل من الكنترول .