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Research Article

# PHYSIOCHEMICAL, PROXIMATE, AND SENSORY PROPERTIES OF UNFERMENTED AND FERMENTED SOY-CARROT BEVERAGES SWEETENED WITH SUGAR, DATE, AND HONEY

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**ABSTRACT**

**Objective:** Physiochemical, proximate, and sensory properties of unfermented and fermented soy-carrot beverage sweetened with sugar, date, and honey were evaluated. Phytochemical content of soymilk, carrot juice, and their blend was also analyzed.

**Methods:** Three sets of soy-carrot beverages were produced by homogenizing soy milk and carrot juice in a ratio of 2:1 and sweetened to 12% Brix. Each set was sweetened with sugar, date, and honey, respectively. A fourth set was unsweetened and served as control. After pasteurization, one part was fermented with pure culture of *Lactobacillus acidophilus* at 42°C for 24 h.

**Results:** Fermentation significantly ($p \leq 0.05$) decreased pH (≥5.40–≤3.90), increased titratable acidity (≤0.55–≥0.90% lactic acid), and viscosity (≤0.65–≥0.87 Pa.S) of the soy-carrot beverages. Moisture, protein, fat, ash, carbohydrate, and energy content of unfermented beverages were 82.95–93.95%, 2.15–2.87%, 0.42–1.21%, 0.10–0.20%, 3.21–12.55%, and 25.46–73.53 Kcal/g, respectively, while fermented beverages had 90.00–93.00%, 2.06–2.20%, 0.88–1.08%, 0.11–10.20%, 4.85–8.75%, and 36.76–52.20 Kcal/g, respectively. Total carotenoid, phenol, and DPPH radical scavenging activity varied, respectively, from 2.40–7.90, 14.81–26.59 mg tannic acid/ml, and 4.02–27.83% and were significantly ($p \leq 0.05$) highest in soy-carrot blend with carrot as major contributor. Degree of likeness of the sensory attributes for the sweetened and unfermented beverages was significantly ($p \leq 0.05$) higher than the fermented.

**Conclusion:** Date and honey (12% Brix) can be used as sucrose alternatives in producing acceptable nutritious beverage from soymilk and carrot juice.

**Keywords:** Fermentation, Soy-carrot beverage, Physicochemical properties, Proximate composition, Sensory properties.

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## INTRODUCTION

Beverages, especially carbonated and sugar sweetened beverages, are popularly consumed because of their sweet taste and flavor. However, soft drinks with high sugar and acidity contribute to detrimental oral health and other general health diseases including fatty liver [1,2]. All over the world, health concerns have led to the popularization of natural drinks as alternatives to carbonated and sweetened beverages. Fruit drinks and juices are nutritious, have a great taste and health benefits [3]. Non-alcoholic beverages serve as after meal drinks or refreshing drinks during the dry season in rural and urban centers [4].

Soybean products are important in household nutrition programs because of their high-protein content and affordability [5]. Soymilk is not technically milk as it does not contain lactose but an aqueous extract of soybean (*Glycine max*) resembling milk after soybeans is soaked, finely ground, and then strained [6,7]. The nutritional composition, appearance, and flavor of good quality soymilk are similar to that of cow milk. Soymilk and cow's milk contain nearly identical amount of protein and water and soymilk has some advantages; it does not contain lactose which is good for lactose intolerant persons, it contains fiber and less amount of fat which is good for the health [7].

Carrot (*Daucus carota*) is one of the root crops grown for its flesh roots for human and animal consumption. It is rich in β-carotenes and also contains ascorbic acid, tocopherol carbohydrates, calcium, phosphorus, iron, potassium, magnesium, copper, manganese, sulfur, and phenolic compounds, but deficient in protein and fat [8,9]. β-carotene in carrot is a precursor of Vitamin A which helps to promote visual health. Other components of carrot impact antioxidant and anticancer activities leading to increase in its consumption [10]. Carrots can be processed into a wide variety of products (carrot juice, dehydrated carrot, juice, beverages, candy, and preserves) among these, carrot juice is the most popular [10,11].

Sucrose is ubiquitously known as common table sugars and is primarily produced from sugarcane (*Saccharum officinarum*) and sugar beet (*Beta vulgaris*) [12]. It is an important component of the modern diet, used mainly as sweetener and contributes metabolizable energy to the diet. However, the need for natural and nutritionally balanced natural products advocates for the use of sucrose alternatives in food production. Hence, indicates that from the reason already given in the previous sentence date and honey can be used in the production of the beverage.

Honey is the natural sweet, viscous substance produced by honeybees (*Apis mellifera*) from the nectar of blossoms or from the secretion of living parts of plants or excretions of plant sucking insects on the living parts of plants, which honeybees collect, transform, and combine with specific substances of their own, store, and leave in the honey comb to ripen and mature [13]. Honey since ancient times has been considered as food, sweetener for foods, and therapeutic agent. It is a good source of micro- and macronutrients and saturated in sugar mainly fructose and glucose, which makes it an excellent source of energy and contributes to its physical characteristics such as hygroscopicity, granulation, and viscosity [14]. Date (*Phoenix dactylifera*) is a delicious fruit with a sweet taste and a fleshy mouth feel. Date flesh is low in fat and protein but high in sugars mainly fructose and glucose [15]. The sugars in dates are easily digested and metabolized to release energy for various cell activities. Dates are also a good source of fiber and contain many important vitamins and minerals, including significant amounts of calcium, iron, fluorine, and selenium [16,17]. Dates have been shown to contain antioxidant and antimutagenic properties and also offer some health benefits [18].

Fermentation is one of the traditional ways of processing soybean. It is a desirable process of biochemical modification of primary food matrix brought about by microorganisms of their enzymes [19]. Fermentation of soy beverages helps to reduce beany flavor and the problem of flatulence and indigestion associated with the presence of raffinose and stachyose, in addition to the enhancement of protein digestion and increase in bioavailability of isoflavones [20]. Fermentation of vegetable juices and low pH of the fermented juice provides better stability of bioactive compounds like Vitamin C [21]. Soymilk is rich in protein which carrot is deficient in. Soymilk can be fortified with carrot juice, which is a good source of beta-carotene and sweeteners can be added to improve sweetness and acceptability of the beverages. Hence, the objective of this study to evaluate the physiochemical, proximate, and sensory properties of unfermented and fermented soy-carrot beverages sweetened with sugar, date, and honey.

## METHODS

### Samples

Soybean (*G. max*), carrot (*D. carota*), honey, date fruit (*P. dactylifera*), and table sugar (sucrose) were purchased from Mile III Market in Port Harcourt, Rivers State, Nigeria.

### Preparation of soy milk

About 500 g of the soybean after sorting to remove foreign matters was soaked overnight in distilled water at room temperature and then dehulled. The dehulled soybean was blended with water (1:5) using a Philips HR2000 blender for 5 min and the milk was extracted by sieving the paste through a muslin cloth. The milk was heated at 95°C for 20 min with constant stirring, cooled, and stored in a refrigerator until required for use.

### Preparation of carrot drink

The method of Banigo *et al*. [22] was used. About 200 g of carrot after sorting, scrapping, and washing was sliced and subjected to extraction using a juice extractor (IIoytron 23438, UK). The pulp obtained was sieved with muslin cloth to further extract more juice.

### Production of the unfermented and fermented soy-carrot beverages sweetened with sugar, date, and honey

Three sets of soy-carrot beverages were produced by blending and homogenizing the soy milk and carrot juice in a ratio of 2:1 using a Binatone blender (BLG 595 MK2, Global Appliances, Nigeria). The beverages were sweetened to 12% Brix. The first set of beverages was sweetened with sugar, the second set was sweetened with date, and the third set was sweetened with honey. The sweetened beverages were homogenized and transferred into sterile glass bottles and pasteurized at 63°C for 15 min using a water bathe (Techno Test, Italy). Each set of the sweetened beverage was divided into two parts: One part was fermented with pure culture of *Lactobacillus acidophilus* at 42°C for 24 h and the other unfermented. The unsweetened served as control.

### Physicochemical (pH, titratable acidity [TTA], viscosity, and sugar) analysis of unfermented and fermented soy-carrot beverages sweetened with sugar, date, and honey

pH, TTA, viscosity, and sugar content of the beverages were determined according to the method of AOAC [23]. pH meter (TS 625, USA), a viscometer (NDJ-85, China), and a handheld portable sugar refractometer (30GS, Hackettstown) were, respectively, used to determine pH, sugar, and viscosity. Titration for TTA was with 0.1 N NaOH and phenolphthalein solution as indicator.

### Proximate composition of unfermented and fermented soy-carrot beverages sweetened with sugar, date, and honey

Proximate analysis was carried out on the samples using standard AOAC [23] methods. Moisture content was calculated after drying at 105°C to constant weight in an air oven (Thermo Scientific-UT 6200, Germany). Determination of protein was by Kjeldahl method. The efficiency of the nitrogen values was corrected with acetanilide values and multiplied by the factor of 6.25 to obtain the protein value. Fat was estimated by exhaustive extraction of known weight of samples with petroleum ether using rapid Soxhlet extraction apparatus (Gerhardt Soxtherm SE-416, Germany). Ash was determined gravimetrically after incineration in a muffle furnace (Carbolite AAF-11/18, UK) for 2 h at 550°C. Carbohydrate content was determined by the difference: 100% - (% MC + % Ash + % Crude protein + % Fat + % Crude fiber). Total solid was obtained by subtracting the moisture content from 100. Energy (Kcal/g) was calculated using the Atwater factor of 4.0 Kcal/g for protein and carbohydrate and 9 Kcal/g for fat.

### Sensory analysis of unfermented and fermented soy-carrot beverages sweetened with sugar, date, and honey

The degree of likeness of the soy-carrot beverages was analyzed using a 20-member panelist consisting of staff and students chosen from the Department of Food Science and Technology, Rivers State University, Port Harcourt, Rivers State, Nigeria. The sensory qualities evaluated were color, flavor, mouth feel, odor, tartness, taste, and overall acceptability. The rating was based on a 9-point hedonic scale with the degree of likeness expressed as: 1 – disliked extremely, 2 – dislike very much, 3 – dislike moderately, 4 – dislike slightly, 5 – neither like nor dislike, 6 – like slightly, 7 – like moderately, 8 – like very much, and 9 – like extremely [24].

### Phytochemical analysis of unfermented and fermented soy-carrot beverage sweetened with sugar, date, and honey

*Total carotenoid determination*

The solvent extraction and spectrophotometric method according to Biswas and Chatli [25] were used with modifications. To 0.5 ml of the soy-carrot sample in a centrifuge tube was added 10 ml of 80% acetone, mixed properly and centrifuge at 4000 rpm for 10 min. Supernatant was made up to 15 ml using 80% ethanol. The absorbance was read at wavelength of 480 nm using UV–visible spectrophotometer. Total carotenoid content (mg/kg) was computed as (4 × OD × Total volume of sample ×100)/sample volume.

*Antioxidant activity (1,1-diphenyl-1picryl-hydrazyl [DPPH] radical scavenging activities)*

The effect of soy-carrot extract on DPPH was determined according to the method of Liyana-Pathiranan and Shahidi [26] with modifications. Briefly, 25 ml of soy-carrot sample in 25 ml of ethanol after vigorous shaken and standing for 2 h was centrifuged at 2500 rpm for 17 min. The supernatant was concentrated by evaporating in a water bath at 80°C to obtain the soy-carrot extract and the concentrations of 0.02, 0.04, 0.06, 0.08, and 0.10 mg/ml of the extract were prepared in ethanol. A solution of 0.135 mM DPPH in ethanol was prepared. The prepared extract (1.5 ml) was mixed with 1.5 ml of the DPPH solution. The absorbance was read off at 517 nm with ethanol as blank and DPPH solution as control. Ascorbic acid was used as standard. Antioxidant capacity as DPPH radical scavenging activity (%) was computed as (Abs of control−Abs of test sample×100)/Abs of control.

*Total phenol determination*

The phenol content of the soy-carrot beverage was determined according to the method of Wolfe *et al*. [27]. Soy-carrot extract was obtained by centrifugation of 10 ml of the beverage to which 10 ml of ethanol was added, vigorously shaken, and allowed to stand for 30 min for proper extraction before centrifugation to obtain clear supernatant. The extract (1 ml) was mixed with 0.5 ml Folin–Ciocalteu reagent and 1.5 ml of $NaCO_3$ solution. The solution was made up to 10 ml with distilled water, shaken vigorously, and allowed to stand for 90 min at 40°C for color development. The absorbance was read off at 765 nm in a UV–VS spectrophotometer (Hewlett Packard, China). Total phenolic content was expressed as mg/g tannic acid equivalent from the calibration curve of the absorbance of 20, 40, 60, 80, 100, and 120 mg/l tannic acid standards.

**Statistical analysis**

Minitab (Release 18.0) Statistical Software (Minitab Ltd., Coventry, UK) was used for data analysis. Statistic differences were obtained using analysis of variance under the general linear model and Fisher pairwise comparison at 95% confidence level.

## RESULTS AND DISCUSSION

### Physicochemical Properties of fermented and unfermented soy-carrot beverages sweetened with sugar, date, and honey

*pH and TTA as % lactic acid*

The pH and TTA of the soy-carrot beverages are shown in Fig. 1. pH of the unfermented and fermented beverages varied from 5.40 to 5.55 and 3.75 to 3.90, respectively. Addition of sugar led to significant ($p \leq 0.05$) increase in the initial pH, while the other sweeteners did not differ from the control. TTA varied from 0.25% to 0.55% lactic acid for the unfermented beverages and 0.90 to 1.31% lactic acid for the fermented beverages. pH of the unfermented beverages is comparable with those reported by Banigo *et al.* [22] for soy-carrot-beetroot drink but lower than the pH of soymilk (6.12–6.28) from different varieties of soybean reported by Nwoke *et al*. [28] and 6.22 for untreated carrot juice [11]. The treatment given to the soy-carrot beverage may have reduced the pH in addition to the inclusion of the sweeteners. Sharma *et al*. [11] reported such decrease in pH of treated carrot juices and sweeteners such as honey are known to have a pH of 3.21–3.50 [29]. Fermentation resulted in significant ($p \leq 0.05$) decrease in pH and increase in TTA. This was expected due to the acid production from the activity of the fermenting microorganism. Such reduction in pH will discourage the growth of spoilage bacteria.

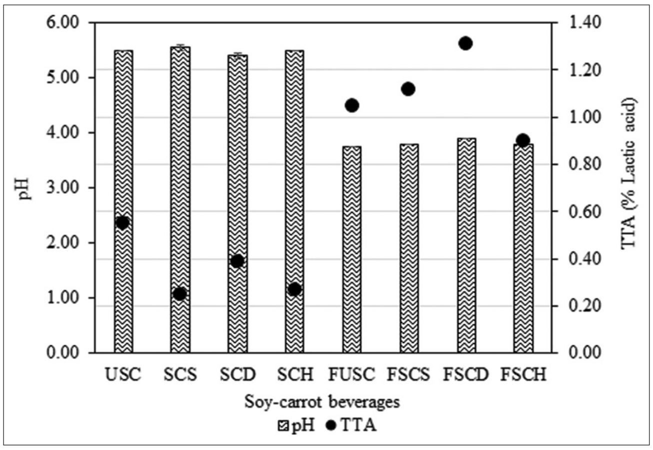


**Fig. 1: pH and titratable acidity (TTA) (%lactic acid) of unfermented and fermented soy-carrot beverages sweetened with sugar, date, and honey. USC: Unsweetened soy-carrot beverage, FUSC: Fermented unsweetened soy-carrot beverage, SCS: Soy-carrot beverage with sugar, FSCS: Fermented soy-carrot beverage with sugar, SCD: Soy-carrot beverage with date, FSCD: Fermented soy-carrot beverage with date, SCH: Soy-carrot beverage with honey, FSCH: Fermented soy-carrot beverage with honey**

*Viscosity and sugar levels*

Shown in Table 1, is the viscosity and sugar levels of the unfermented and fermented soy-carrot beverages sweetened with sugar, date and honey. The viscosity of the unfermented samples varied from 0.51 to 0.65 Pa.S. These values are lower than the report for soy-carrot-beetroot drink [22], the addition of sweeteners could be responsible for this difference. Samples with sugar and date had significantly ($p \leq 0.05$) higher initial viscosity. Addition of sweeteners resulted in increase in viscosity, with date having significantly ($p \leq 0.05$) higher viscosity than honey. Fermentation increased the viscosity of the samples and it varied from 0.64 to 0.87 Pa.S for samples with honey and sugar, respectively. There was no difference in the sugar (Brix) content of the beverages, the values were 5 Brix for the control and 12 Brix for the sweetened beverages. Fermentation had no effect on the Brix content. Although sugar is a ready substrate for fermenting microorganisms, within the short period of fermentation, the microorganism while utilizing the sugars, hydrolysis of carbohydrate components of the beverages into simple sugars by starch hydrolyzing enzymes may have been responsible for maintaining the sugar content.

**Table 1: Viscosity and sugar levels of unfermented and fermented soy-carrot beverages sweetened with sugar, date, and honey**

| Samples | Viscosity (Pa.S) | Sugar level (Brix) |
|---|---|---|
| USC | $0.51 \pm 0.01^{d}$ | 5 |
| SCS | $0.64 \pm 0.01^{c}$ | 12 |
| SCD | $0.65 \pm 0.00^{c}$ | 12 |
| SCH | $0.57 \pm 0.03^{d}$ | 12 |
| FUSC | $0.66 \pm 0.02^{bc}$ | 5 |
| FSCS | $0.87 \pm 0.01^{a}$ | 12 |
| FSCD | $0.71 \pm 0.00^{b}$ | 12 |
| FSCH | $0.64 \pm 0.00^{c}$ | 12 |

Means with the same superscript in the same column do not differ significantly ($p \leq 0.05$) N=3 ± SD. USC: Unsweetened soy-carrot beverage, FUSC: Fermented unsweetened soy-carrot beverage, SCS: Soy-carrot beverage with sugar, FSCS: Fermented soy-carrot beverage with sugar, SCD: Soy-carrot beverage with date, FSCD: Fermented soy-carrot beverage with date, SCH: Soy-carrot beverage with honey, FSCH: Fermented soy-carrot beverage with honey

### Proximate composition of fermented and unfermented soy-carrot beverages sweetened with sugar, date, and honey

Proximate composition of the unfermented and fermented soy-carrot beverages sweetened with sugar, date, and honey is shown in Table 2.

Moisture content varied from 82.95 to 93.95% and 90.00 to 93.00% for unfermented and fermented beverages. The water used in the extraction of the soymilk and the carrot juice contributed to the high moisture content of the beverages. This high moisture content is ideal for refreshing and thirst quenching needs and is in line with other beverages and juices [22,30,31]. There was a significant ($p \leq 0.05$) decrease in moisture with the addition of sweeteners and the samples with sugar had significantly ($p \leq 0.05$) the least moisture content. The decrease in moisture content with the addition of sweeteners is attributable to the water binding ability of the sweeteners. Fermentation had no significant ($p \leq 0.05$) effect on the moisture content of the control but resulted in significant ($p \leq 0.05$) increase in that of the sweetened beverages. The fermented beverage with date had significantly ($p \leq 0.05$) the highest increase in moisture and honey the least. The increase in moisture content with fermentation could be due to the breakdown of complex carbohydrate and the release of binding moisture.

The protein content of the unfermented and fermented beverages was 2.15–2.87% and 2.06–2.20%, respectively. These protein values were lower than those of dairy origin but similar to the protein content reported by Madukwe *et al*. [32] and Banigo *et al.* [22]. For the unfermented beverages, sample with date had significantly ($p \leq 0.05$) the highest protein content and honey the least. The increase in protein with the addition of date brings to mind the report that date has high content (2.0–2.2%) of protein [33]. The fermented samples had significant ($p \leq 0.05$) decrease in protein content of the control and beverages with sugar and date. The decrease can be attributed to the activities of the fermenting microorganisms as they utilize some amino acid during fermentation and lower the protein content [34].

There was significant ($p \leq 0.05$) variation in the fat content of the beverages. For the unfermented samples, addition of sweeteners increased the fat content and the values were 0.42–1.21% for the control and beverages with sugar, respectively. Fat content of the fermented beverages varied from 0.88% to 1.08% for beverages with honey and sugar, respectively. Fat increased significantly ($p \leq 0.05$) with fermentation for the control and beverages with date, while others had significant (p≤0.05) decrease. The fat content is lower than the values for soymilk (1.98–2.18%) but higher for carrot (0.16%) reported by Nwoke *et al*. [28] and Wakili *et al*. [35]. The low fat content can partly be attributed to the carrot and it is ideal on health reasons as consumers are looking for food products with reduced fat content.

The ash content of the unfermented beverages ranged from 0.10% to 0.20%. There was no significant (p≤0.05) difference in the ash content of the control, and the beverages containing sugar and date. Ash decreased with addition of honey. The ash content of the fermented beverages was 0.11–0.20%. Fermentation had no significant (p≤0.05) effect on the ash content of the control but resulted in significant (p≤0.05) increase in the content of the beverage with honey and decrease in beverages with sugar and date. Ash is a representation of the mineral content of the food, the increase in ash content of the beverages with fermentation could imply a release of minerals through the microbial activity.

The carbohydrate content of the unfermented and fermented samples ranged from 3.21 to 12.55% and 4.85 to 8.75%, respectively. Addition of sweeteners significantly (p≤0.05) increased the carbohydrate content of the beverages with sugar significantly (p≤0.05) the highest. There was decrease in carbohydrate content with fermentation for the sweetened

**Table 2: Proximate composition (%) of unfermented and fermented soy-carrot beverages sweetened with sugar, date, and honey**

| Samples | Moisture | Total solid | Protein | Fat | Ash | Carbohydrate | Energy (Kcal/g) |
|---|---|---|---|---|---|---|---|
| USC | 93.95±0.05$^{a}$ | 6.05±0.05$^{f}$ | 2.21±0.00$^{c}$ | 0.42±0.06$^{f}$ | 0.20±0.00$^{a}$ | 3.21±0.10$^{g}$ | 25.46±0.10$^{g}$ |
| SCS | 82.95±0.15$^{f}$ | 17.05±0.15$^{a}$ | 2.38±0.00$^{b}$ | 1.21±0.01$^{a}$ | 0.20±0.00$^{a}$ | 13.28±0.15$^{a}$ | 73.53±0.13$^{a}$ |
| SCD | 85.30±0.20$^{d}$ | 14.70±0.20$^{c}$ | 2.78±0.00$^{a}$ | 0.78±0.01$^{e}$ | 0.20±0.00$^{a}$ | 10.94±0.22$^{c}$ | 61.90±0.21$^{c}$ |
| SCH | 84.10±0.10$^{e}$ | 15.90±0.10$^{b}$ | 2.15±0.00$^{de}$ | 1.10±0.00$^{b}$ | 0.10±0.00$^{c}$ | 12.55±0.10$^{b}$ | 68.70±0.10$^{b}$ |
| FUSC | 93.60±0.10$^{a}$ | 6.40±0.10$^{f}$ | 2.09±0.01$^{de}$ | 1.00±0.00$^{c}$ | 0.20±0.00$^{a}$ | 4.85±0.10$^{f}$ | 36.76±0.11$^{f}$ |
| FSCS | 90.10±0.10$^{c}$ | 9.90±0.10$^{d}$ | 2.20±0.06$^{cd}$ | 1.08±0.02$^{b}$ | 0.11±0.00$^{c}$ | 8.42±0.11$^{d}$ | 52.20±0.20$^{d}$ |
| FSCD | 92.60±0.10$^{b}$ | 7.40±0.10$^{e}$ | 2.06±0.06$^{e}$ | 0.98±0.03$^{c}$ | 0.15±0.00$^{b}$ | 5.97±0.09$^{e}$ | 40.94±0.12$^{e}$ |
| FSCH | 89.90±0.20$^{c}$ | 10.10±0.20$^{d}$ | 2.06±0.04$^{e}$ | 0.88±0.01$^{d}$ | 0.20±0.00$^{a}$ | 8.75±0.21$^{d}$ | 51.16±0.22$^{d}$ |

Means with the same superscript in the same column do not differ significantly (p≤0.05) n=3 ± SD. USC: Unsweetened soy-carrot beverage, FUSC: Fermented unsweetened soy-carrot beverage, SCS: Soy-carrot beverage with sugar, FSCS: Fermented soy-carrot beverage with sugar, SCD: Soy-carrot beverage with date, FSCD: Fermented soy-carrot beverage with date, SCH: Soy-carrot beverage with honey, FSCH: Fermented soy-carrot beverage with honey

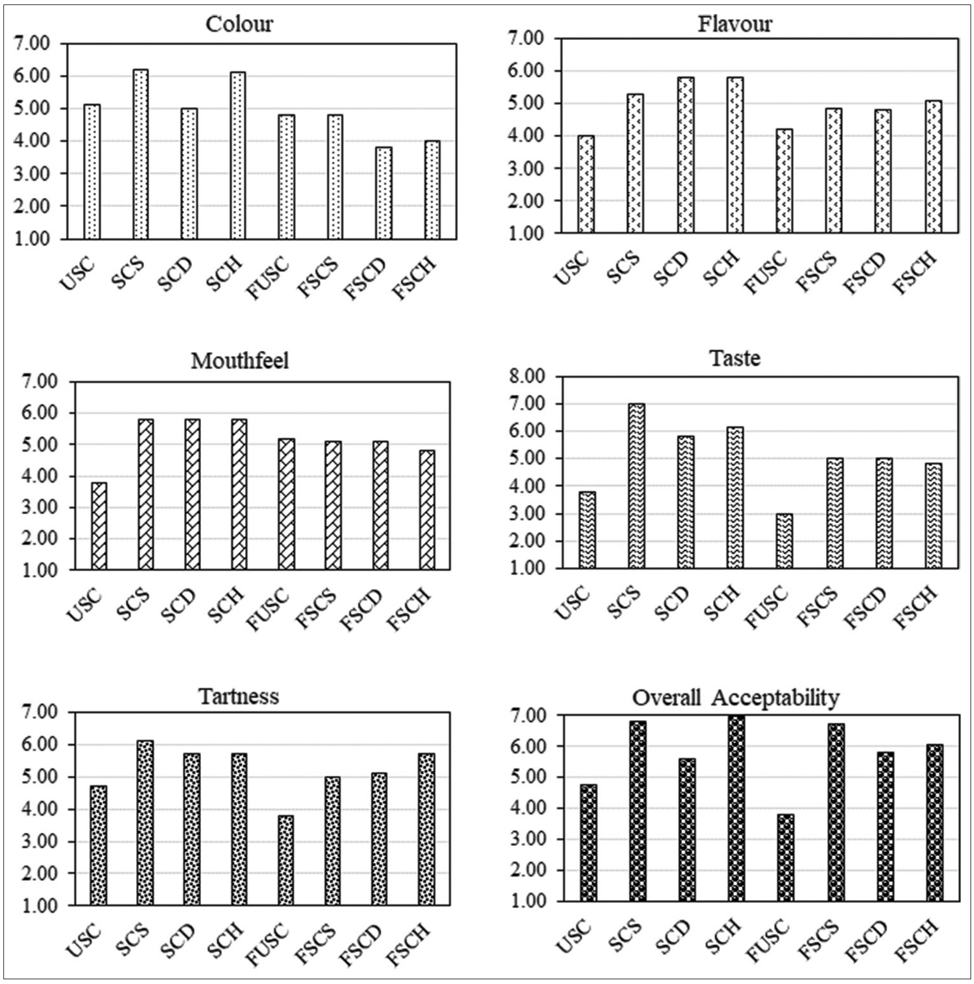


**Fig. 2: Sensory properties of unfermented and fermented soy-carrot beverages sweetened with sugar, date, and honey. USC: Unsweetened soy-carrot beverage, FUSC: Fermented unsweetened soy-carrot beverage, SCS: Soy-carrot beverage with sugar, FSCS: Fermented soy-carrot beverage with sugar, SCD: Soy-carrot beverage with date, FSCD: Fermented soy-carrot beverage with date, SCH: Soy-carrot beverage with honey, FSCH: Fermented soy-carrot beverage with honey**

beverages while the control had an increase. The major carbohydrate in legumes is starch while those in the sweeteners used are mainly sugars. During fermentation, starch hydrolyzing enzymes such as α-amylase and maltase which, respectively, degrade starch into maltodextrins and simple sugars are activated and sugars, particularly glucose, are ready substrate for the fermenting organism [36]. The decrease in the carbohydrate content could therefore be attributed to its utilization by the fermenting microorganisms. The energy content followed the same trend as carbohydrate and the values of the unfermented and fermented samples ranged from 25.46 to 73.53 and 36.76 to 52.20 Kcal/g, respectively.

### Sensory evaluation

The degree of likeness of the sensory attributes of the soy-carrot beverages is shown in Fig. 2. The assessors' degree of likeness for the sensory attributes (color, flavor, mouthfeel, taste, tartness, and overall acceptability) of the beverages varied significantly ($p \leq 0.05$). The values for the unfermented and fermented beverages were, respectively, 5.00–6.20 and 3.81–4.83 for color, 4.00–5.82 and 4.23–5.11 for flavor, 3.81–5.82 and 4.81–5.23 for mouthfeel, 3.81–7.03 and 3.00–5.02 for taste, 4.70–6.12 and 3.81–5.70 for tartness, and 4.73–6.81 and 3.81–6.70 for overall acceptability. The sweeteners significantly ($p \leq 0.05$) improved on the likeness of the sensory attributes of the unfermented beverages. The assessors' degree of likeness for beverages with sugar was significantly ($p \leq 0.05$) the most: Between slight to moderate likeness while the control was significantly ($p \leq 0.05$) the least, between dislike moderately to neither like nor dislike. Fermentation resulted in significant ($p \leq 0.05$) decrease in assessor's degree of likeness. In general, most beverages are not consumed as fermented product except for yoghurts, this could explain the decrease in assessors' degree of likes of the fermented soy-carrot beverage although fermentation with fortified fruits according to Kiros *et al*. [9], has the potential to improve the nutrient and health benefits of the product.

### Phytochemical composition of plain unfermented soy, carrot, and soy-carrot beverages

The total carotenoid, total phenol, and DPP radical scavenging activity of the soy milk, carrot, and soy-carrot beverages are shown in Table 3. The phytochemical content of the beverages varied significantly ($p \leq 0.05$) and the values were 2.40–7.90, 14.81–26.59 mg tannic acid/ml, and 4.02–27.83%, respectively, for total carotenoid, total phenol, and DPPH radical scavenging activity. Soymilk had significantly ($p \leq 0.05$) the least content of total phenol and DPP radical scavenging activity while its total carotenoid content was below detection level. Soy-carrot blend had significantly ($p \leq 0.05$) the highest phytochemical content and is attributable to the carrot juice. According to Rodriguez-Amaya, [37], carrot is the lonely colored root crop that imparts antioxidant properties in addition to color. Furthermore, antioxidant activity of polyphenols in carrot juices is retained after processing [38]. Carotenoid is important as a precursor of Vitamin A for those containing β-rings. It is converted into retinol and other related retinoids that are vital in visual cycle and gene regulation among other health benefits [39]. Plant phenols are strong antioxidants and prevent damage to biomolecules and play a significant role in chronic disease prevention [40]. DPPH assay is widely used in assessing the antioxidant capabilities, the higher value of the soy-carrot beverage is an indication of high ability of loose hydrogen and neutralizes the synthetic free radical that does not disintegrate in water, ethanol, or methanol [41]. The soy-carrot beverage is, therefore, a good source of antioxidant with carrot juice as the major contributor.

**Table 3: Phytochemical composition of plain unfermented soy, carrot, and soy-carrot beverages**

| Samples | Total carotenoid | Total phenol (mg tannic acid/ml) | DPPH radical scavenging activity (%) |
|---|---|---|---|
| Carrot juice | 7.90±0.10[a] | 20.20±0.36[b] | 9.18±0.30[b] |
| Soymilk | ND | 14.81±0.02[c] | 4.02±0.31[c] |
| Soy-carrot beverage | 2.40±0.10[b] | 26.59±0.70[a] | 27.83±1.00[a] |

Means with the same superscript in the same column do not differ significantly ($p \leq 0.05$) n=3 ± SD. ND: Not detected

## CONCLUSION

An acceptable nutritious beverage with 12% Brix of sugar, date, and honey was produced from soymilk and carrot. Addition of the sweeteners improved on the physicochemical, proximate, and sensory properties of the beverages. Beverages with date and honey were comparable with those of sugar. Although fermentation resulted in significant ($p \leq 0.05$) decreases, the decrease in pH and increase in acidity can offer storage stability. The beverage can also be fermented for a novel refreshing drink. It was also observed that the soy-carrot beverage contained antioxidant with carrot juice as the major contributor. Date and honey (12% Brix) can, therefore, be used in place of sugar in producing acceptable nutritious antioxidant-rich beverage from soymilk and carrot blend. More research is required in to ascertain the storage stability of this beverage under different storage conditions.

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