Utilization of Sudanese *sidr* (*Ziziphus spina-christi* L) for jam manufacture

Altayp Abd arahman Altayp[1] and Nawal Abdel-Gayoum Abdel-Rahman[2]

Department of Nutrition, Ministry of Health, Gadarif State

1 e-mail: altayp1181@gmail.com

2 Food Research Centre, P. O. Box 213, Khartoum North – Sudan

e-mail: ibreez2005@gmail.com

Abstract

The purpose of this study was to assess the physicochemical properties of *sidr* (*Zizyphus spina-christiL*) fruits (*Nabaq*). As well as, to choice the best extraction method, processing *Nabaq* jam and evaluate its suitability during storage. The jam processed from *Nabaq* pulp was filled into glass jars containers. Organoleptic attributes, physico-chemical properties were carried out for the processed jams. Total soluble solids (TSS), pH, total titratable acidity (TTA), total and reducing sugars were determined. The results showed that the *Nabaq* forest fruit contains high level of energy, vitamin C, beta-carotene and protein. As well as, contain several minerals such as Na, K, Ca, Mg and P. The results observed that the highest yield of cold and hot extraction; from 20 kg *Nabaq*; were 19.09 and 13.75 g with total soluble solids of 3 and 2%, respectively. The developed *Nabaq* jam had 68 %, 3.40, 0.30, 40.95 and 7.39 as levels of TSS %, pH, TTA %, total reducing sugars. The developed jams (without and with pineapple flavuor) were showed that no significant (P>0.05) differences in quality attributes, and the panelist were accepted both of jams.

Key words: *Nabaq*; jam; cold extraction; hot extraction; develop; inexpensive

Introduction

The world's forests are playing a crucial role in the eradication of hunger and improve livelihoods (**FAO, 2015**). Tropical forest and savannah lands are containing many edible indigenous trees. The forest fruits are essential to increscent the nutritional value of the diet with macro and micronutrients in the rural areas (**FAO, 2012; Abdel Muti, 2002**). *Sidr* (*Zizyphus spina-christi L*) is belongs to the *Rhamnaceae* family; it is an edible and medicine forest fruits distributed in warm areas and tropical regions. In Sudan, the fruits of *sidr* tree

called *Nabaq*, and which is grown throughout Sudan regions; desert and semi-desert arid parts (**El-Khalefa, 1996**). But, it is abundant in western Sudan in the states of Kordufan and Darfur. *Nabaq* is one of indigenous forest fruits, bally in figure, the shiny skin colour is brownish to red, edible flesh and seeds are beige in colour and the test of edible part is sweet.

Traditionally, *Nabaq* forest fruits have numerous proposes; firstly, as medicine, **Okoko and Oruambo (2008**) mentioned that the fruits of *sidr* tree are inexpensive and used to development of human fitness and prevention of diseases, to treat pulmonary ailments, fevers, dysentery, and to therapeutic of new wounds (**Asgarpanah and Haghighat, 2012; Abalaka *et al*., 2010**; **Nazif, 2002; Adzu *et al*., 2001**). As well as, it is used to reduce toothaches pains, astringents and as a mouth wash (**Waggas and Al-hasani, 2010a**). Secondly, as food, it is eaten similar to common fruits (fresh or dry), processed as sheet or leather, and crushed to make a light porridge called *Nasha* or *Madeda*. Fully ripened edible part of *Nabaq* has aromatic smell, and it is rich in many nutrients, such as, protein, carbohydrates and fibre (**Duke, 1985**); also, energy value and vitamin C (**Waggas and Al-hasani, 2009**b). As well as, *sidr* fruits contains abundant levels of calcium, potassium, sodium, phosphorous, copper, iron, and zinc (**Nyanga *et al*.; 2013**).

Hot manufacturing has most of the attributes of perfect food protection (**Chipurura and Muchuweti, 2010**). The preservation of fruit by jam making is a recognizable procedure carried out on a little quantity by housewives in many countries throughout the world (**Abdel-Rahman, 2012**). The objectives of this study were determined the physico-chemical properties of *Nabaq* forest fruits, extracted, processed and stability of processed jam during storage.

Materials and Methods

The fruits of *sidr* tree; *Nabaq*; were purchased from Central market of Khartoum North, Sudan.

Physical properties

The physical properties were determined according to **Abdel-Rahman *et al.* (2014**) included figure (whole fruits and seeds), colour (skin, edible part and seeds) and taste. In addition, the dimensions of forest fruit (length, width and thickness), *Nabaq* weight and percentages of fruit parts (edible part + seeds and peels).

Extraction methods

Cold and hot soaking: *Nabaq* fruits under study were sorted, cleaned, peeled and crushed. The crushed *Nabaq* fruits were soaked with cold and hot water (100 ^{0}C), and the extracts were obtained from various ratios (1: 4, 1:5, 1:6, 1:8 and 1:10 w/v; 20 kg for each ratio) at ambient temperature for 16 and 1 hr, respectively. Soaked fruits were pulped by a magnetic stirrer (model: Galen /camp P2375, England), for 5 minutes. Instantly, soaked fruits were filtered and weighed. The extracts of *Nabaq* fruits were evaluated for its weight, volume, pH, total soluble solids (T.S. S %) and yield (%).

$$Yield\% = \frac{\{T.S.S\% \times weight\ of\ extract\ (g)\} \times 100\%}{Initial\ weight\ of\ sample\ (g)}$$

Jam processing

Nabaq pulp was divided into two batches, with and without pineapple flavour; and processed as jam using procedure suggested by **Singh *et al***. (2009).

Physico-chemical analyses

The proximate composition, sugars and pectin content were evaluated according to the methods described in **AOAC (2000**). Carbohydrates and energy value were calculated according to **West *et al*. (1988)** and **IMNA** (2002), respectively. Total Soluble Solids (TSS), pH, total acidity (TA) and vitamin C were determined according to **Ranganna** (2001). While, the minerals content were evaluated using the methods recorded by **Pearson (1982**), and beta-carotene was determined according to **Dietz *et al*. (1988)**.

Quality attributes: The quality attributes were evaluated by the ranking method (**Ali and El-Faki, 2006**).

Statistical analysis: The statistical analyses were analyzed using Statistical Analysis System (SAS) according to **Musa (2006**).

Results and Discussion

Physical properties:

Physical properties of *Nabaq* forest fruits were presented in Table 1. The fruits and its seeds have bally shape; the colour of skin is brown, while, edible portion and seeds are beige in colour. These fruits are small in average of dimension, the length, width and thickness equivalent to 1.30, 1.40 and 1.38 cm,

respectively. Besides 1.27 g in average weight of whole fruit, 55 % edible portion plus peels, and 45 % percentages of seed.

Physico-chemical composition:

Physico-chemical composition of *Nabaq* was presented in Table 2. The findings of proximate composition obtained in this study were higher in protein, ash, carbohydrates and energy value; whereas, lower in moisture, ash and fat than the results recorded by **Duke (1985**). It is clear from these results; *Nabaq* fruits are rich in macronutrients such as protein, carbohydrates and energy value. **Asgarpanah and Haghighat (2012**) reported that *sidr* fruits are very nutritious and healthful. The results analyses of *Nabaq* forest fruits appeared abundant amounts of total and reducing sugars of 22.62 16.50 %, respectively; and total titratable acidity of 0.18%. The level of vitamin C (90.45 mg/100g) and ß-carotene (46.13_IU/100g) of *Nabaq* is superior to 51.62 mg/100g (orange) and 78 IU/100g (banana) reported by **Fasoyiro *et al.* (2005)** and **Rathore (2009**), respectively. Furthermore, *Nabaq* fruits contain 0.41 % of pectin; this value is approximately half to 0.88% mentioned by **Ahmed *et al.* (1998**) for Indian guava fruits. On the other hand, the minerals content of *Nabaq* frits and jam are showed in Table 3. The amounts of Na, K, Ca, Mg and P of *Nabaq* fruits obtained in this investigation were 53, 70, 420, 135 and 41 mg/100g, respectively. Those values were closed to result of 55, 67, 452, 135 and 35 mg/100 g, respectively mentioned by **Amoo and Atasie (2012**). The contents of jam the same Table

Tables 4 and 5 indicated that the five ratios; cold and hot extraction; were used to extract fruits pulp. The weight, volume and yield of extract rose with progressive ratios. Whereas, TSS % declined with raising the ratios, this might be attributing to increase of water volume put in *Nabaq* fruits. These results were agreement with results reported by Mohammed *et al*. (2013) for baobab (*Adansonia digitata* L.) extracts. Therefore, the best soaking ratio from both methods (cold and hot) according to TSS and yield is 1: 10 (fruit: water, w/v). The TSS % and yield obtained from cold and extraction were 3, 2% and 19.09, 13.75 g, respectively. The effect of extraction method (cold and hot) and ratios on above parameters were shown in figures 1, 2, 3, 4 and 5.

The TSS %, pH,-value, TTA, total and reducing sugars of *Nabaq* fruit jam is illustrated in Table 6. From the data, it is obvious that the jam contains normal TSS%, pH and TTA compare with many authors (**Abdel-Rahman, 2012; Singh**

***et al*., 2009**). While, the total sugars (40.95 %) and reducing sugars (7.39 %) are decreasing, it might be due to the variety used to produce the jam (*Nabaq* forest fruits). However, the levels of total sugars and reducing sugars of *Naba* jams were superior to that in *Nabaq* fruits. **Nour et al. (2010)** reported of 57.14 and 21.94 % as total and reducing sugars, respectively, for *abusamaka* mango jam.

The sensory evaluation of *Nabaq* jams were illustrated in Table 7 and figure 1. The results showed that no significant differences (P>0.05) of the scores of all attributes between the two jams (without and with pineapple flavour), even the general acceptability scores. Furthermore, according to the panelist, the both jams were more delectable and acceptable.

It concludes that, *Nabaq* fruits obtained from *sidr* trees have a good nutritional value. The cold method of extraction resulted acceptable TSS with high percentage of yield. Developing product t is economically for the manufacture of a *Nabaq* jam. More studies might be important to improve the added value of this inexpensive forest fruit.

Table 1: Visual and physical properties of *Nabaq* forest fruit

Visual parameters						
Figure	Skin colour	Edible part colour	Taste	Seeds colour	Seeds count	Seeds figure
Bally	Brown	Beige	Sweety	Beige	1	Bally
Physical parameters						
Length (cm)	Width (cm)	Thickness (cm)	Weight (g)	Edible parts + peels (%)	Seed (%)	
1.30	1.40	1.38	1.27	55	45	

Table 2: Physico-chemical composition of *Nabaq* forest fruit

Proximate composition (%)						
Moisture	Crude protein	Crude fibre	Fat	Ash	Carbohydrates	Energy value (kcal/100g)
3.65	6.13	3.71	0.84	2.86	86.46	387

Physico-chemical composition (%)					
Total sugars	Reducing sugars	TTA	Vitamin C (mg/100g)	ß-carotene (IU/100 g)	Pectin
22.62	16.50	0.18	90.46	46.13	0.41

Table 3. Mineral profile (mg/100g) of *Nabaq* foest fruits and jams

Sample	Na	K	Ca	M g	P
***Nabaq* fruits**	53	70	420	135	41
***Nabaq* Jam**	-	55	75	30	-

Table 4. Cold extraction of *Nabaq* forest fruits

Parameter	Fruit : water ratio (w/v)				$Lsd_{0.05}$	SE±
	1:5	1:6	1:8	1:10		
***Nabaq* fruit weight (g)**	20	20	20	20		
Extract weight (g)	26.57^{d} ±0.18	59.26^{c} ±0.39	89.30^{b} ±0.47	128.58^{a} ±0.79	29.68^{**}	13.52
Extract volume (ml)	27.00^{d} ±0.20	61.00^{c} ±0.42	91.00^{b} ±0.52	132.00^{a} ±0.85	23.57^{**}	11.08

T.S.S %	6.00^{a} ±0.08	5.00^{ab} ±0.05	4.00^{c} ±0.03	3.00^{cd} ±0.01	0.9344*	0.324
pH-value	4.15^{a} ±0.03	4.03^{a} ±0.02	4.25^{a} ±0.04	4.39^{a} ±0.04	0.3758^{Ns}	0.067
Yield (%)	7.73^{d} ±0.06	14.58^{c} ±0.13	17.09^{b} ±0.16	19.09^{a} ±0.17	1.516*	0.598

Values are mean±SD.

Mean(s) sharing same superscript(s) in a row are not significantly (P>0.05) different according to DMRT.

Ns ≡ not significant

Table 5. Hot extraction of *Nabaq* forest fruits

Parameter	**Fruit : water ratio (w/v)**				**Lsd$_{0.05}$**	**SE±**
	1:5	**1:6**	**1:8**	**1:10**		
***Nabaq* fruit weight (g)**	20	20	20	20		
Extract weight (g)	52.65^{d} ±0.26	74.84^{c} ±0.35	94.23^{b} ±0.41	140.34^{a} ±0.83	28.57**	12.67
Extract volume (ml)	55.00^{d} ±0.28	76.00^{c} ±0.37	92.00^{b} ±0.39	142.00^{a} ±0.85	21.34**	9.52
T.S.S %	3.00^{a} ±0.05	2.00^{b} ±0.03	2.00^{b} ±0.03	2.00^{b} ±0.03	0.8092*	0.459
pH-value	4.17^{a} ±0.05	4.34^{a} ±0.07	4.30^{a} ±0.06	4.31^{a} ±0.06	0.4256^{Ns}	0.058
Yield (%)	7.72^{c} ±0.09	7.25^{c} ±0.07	9.24^{b} ±0.13	13.75^{a} ±0.16	1.089*	0.476

Values are mean±SD.

Mean(s) sharing same superscript(s) in a row are not significantly (P>0.05) different according to DMRT.

Ns ≡ not significant

Table 6: Physico-chemical properties of *sidr* forest fruit jam

TSS (%)	pH	TTA (%)*	Total sugars (%)	Reducing sugars (%)
68	3.40	0.30	40.95	7.39

*as citric acid

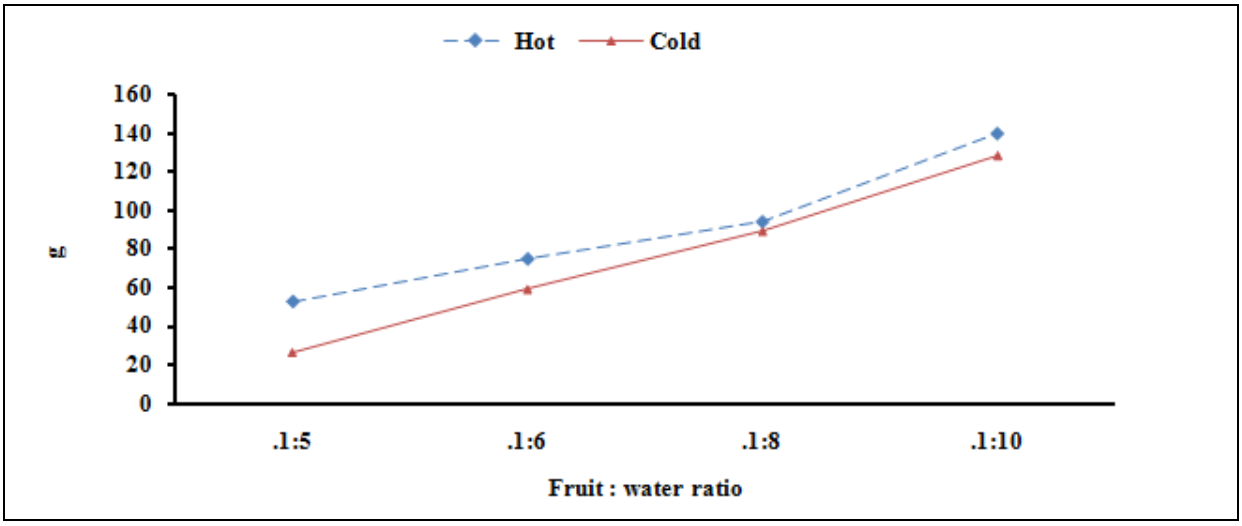

Fig. 1: effect of extraction method and ratio on extract weight

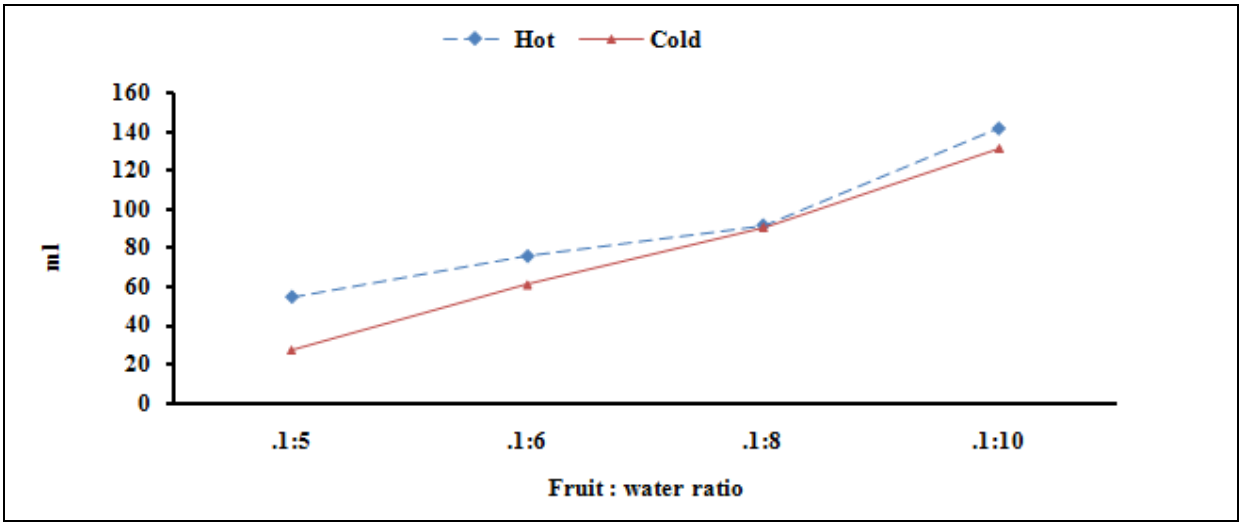

Fig. 2: effect of extraction method and ratio on extract volume

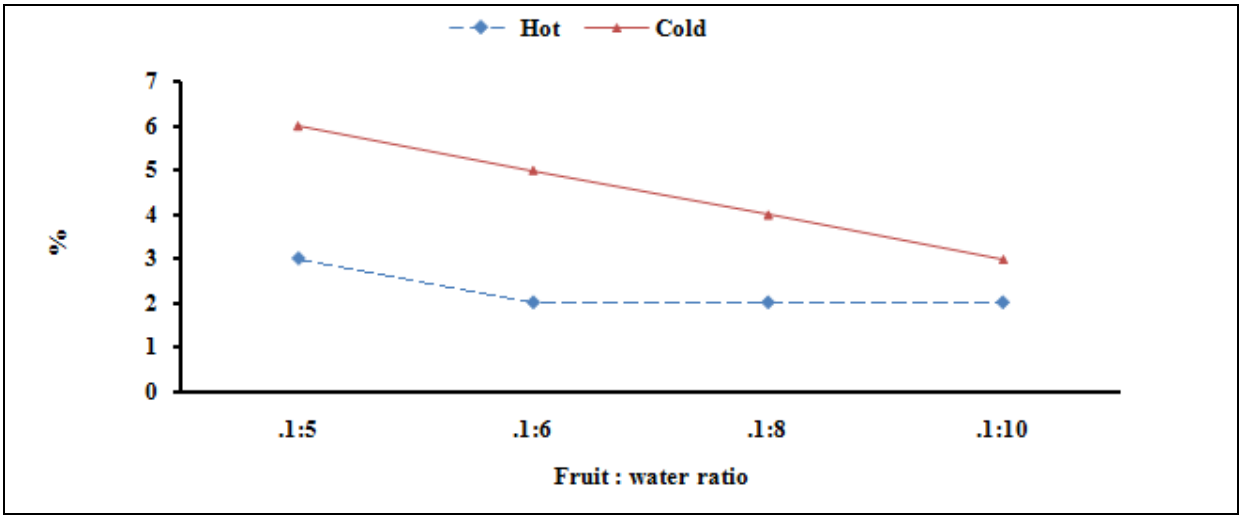

Fig. 3: effect of extraction method and ratio on TSS

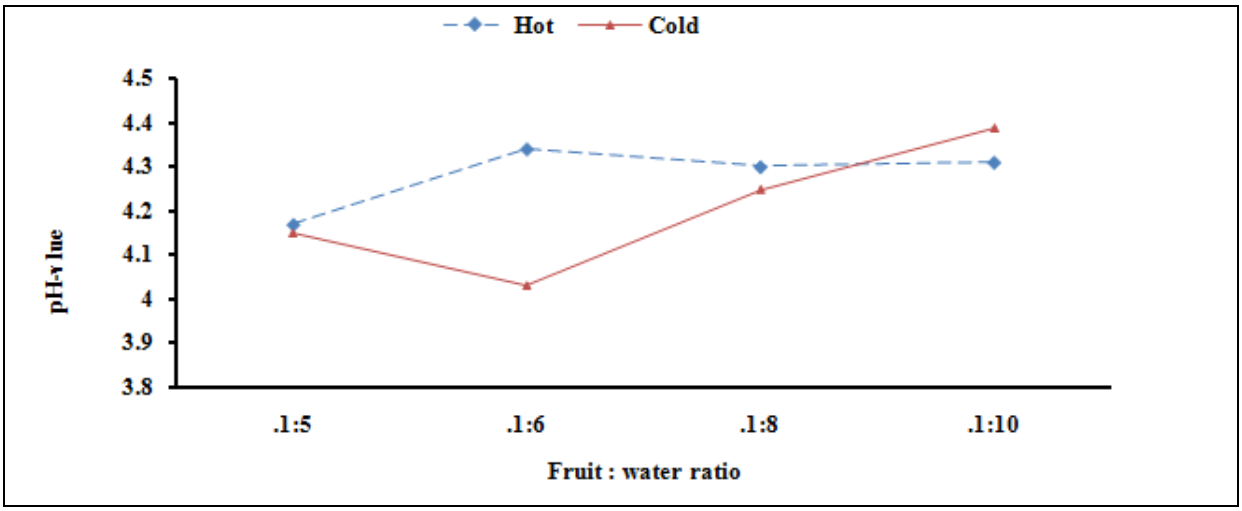

Fig. 4: effect of extraction method and ratio on pH-value

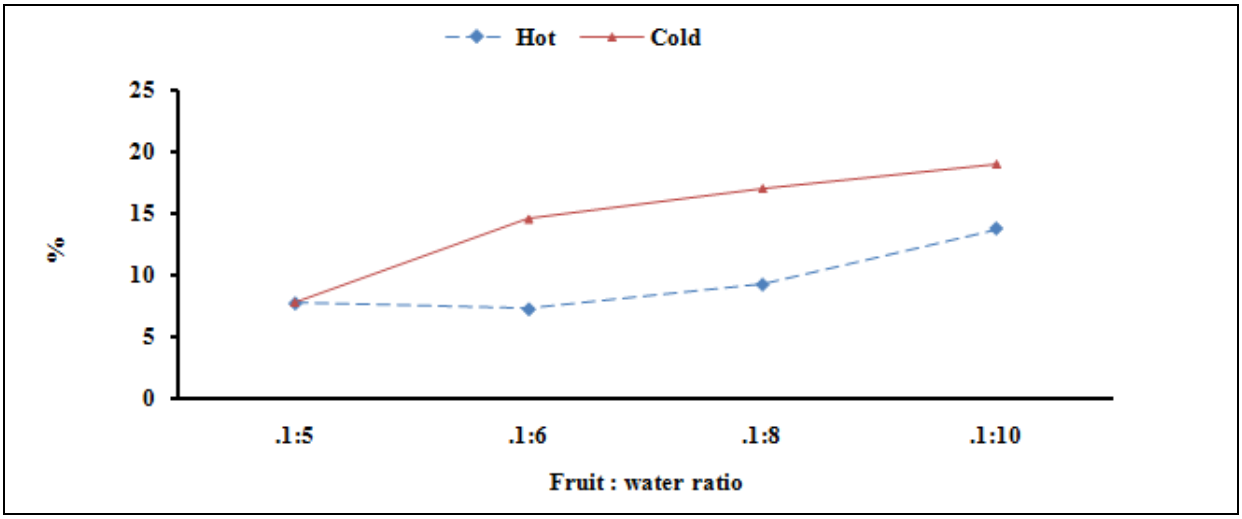

Fig. 5: effect of extraction method and ratio on yield

Table 7: Sensory evaluation

Quality attribute	A	B	$Lsd_{0.05}$	SE±
	Scores			
Taste	1.93^{a}±0.78	1.53^{a}±0.41	0.4091^{Ns}	0.1641
Colour	2.33^{a}±0.95	2.13^{a}±1.12	0.2827^{Ns}	0.0836
Texture	2.33^{a}±0.97	2.33^{a}±1.11	0.0134^{Ns}	0.0092
Flavour	2.20^{a}±1.26	1.13^{a}±0.35	1.0674^{Ns}	0.5273
General acceptability	2.33^{a}±1.09	1.80^{a}±0.86	0.5415^{Ns}	0.2918

Values are mean±SD.

Mean(s) sharing same superscript(s) in a row are not significantly (P>0.05) different according to DMRT.

Ns ≡ not significant

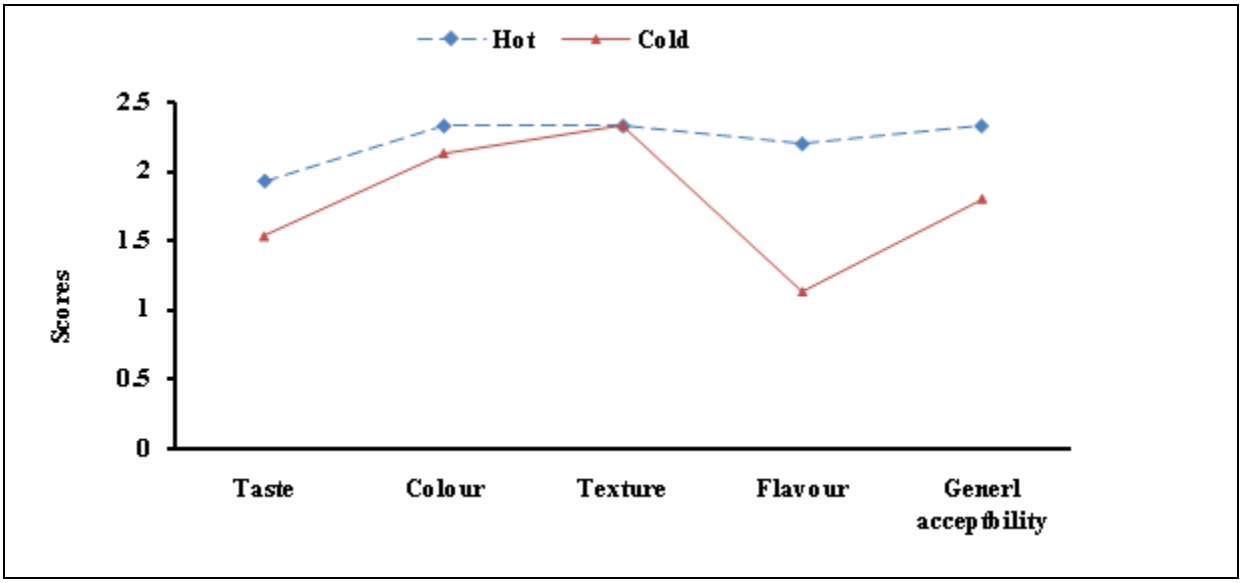

Fig 6: Sensory evaluation of *Nabaq* forest fruit jams

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