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Characteristics of Apricot Jam Sweetened with Saccharin and Xylitol

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ABSTRACT

Preparation of some apricot jams using non-sugar sweetening agents was attempted by either saccharin or xylitol, or a mixture of both. Veltol was added to avoid bitterness.

There were no changes in the Total Soluble Solids and Total Sugars of this jam during storage for 8 weeks at room temperature. However, a gradual decrease in non-reducing sugars, accompanied by an increase in reducing sugars, occurred. The ascorbic acid content decreased by prolongation of the storage time.

Viscosity increased gradually while color faded. Jam sweetened by saccharin and xylitol scored the lowest color index relative to sugar-sweetened jam.

Organoleptically, jam containing saccharin compared favourably with the control. The addition of xylitol or veltol with saccharin markedly improved color and taste of the product without changes in such properties during storage.

INTRODUCTION

Non-nutritive sweeteners are not used as a source of energy. Formerly, saccharin was widely used as a non-nutritive sweetener. Nowadays, it is the only non-nutritive sweetener approved in many countries. Weast (1950), Griffin (1967) and Yoshida & Yoshikada (1967) reported that the sole use of saccharin in concentrations of 0·03% and 0·50% in jam resulted

in a somewhat bitter after-taste. Because saccharin is non-viscous, several investigators proposed the use of pectin to improve jam quality and acceptability (Weast, 1950; Anon, 1959; Lawrence, 1965).

Xylitol, a polyalcohol almost similar to sucrose in sweetness, has been used with fructose and corn-syrup in producing ice-cream type frozen desserts (Ruben Abril *et al.*, 1982).

Veltol (maltol) can increase the consumer acceptance of many products and is used as a balancing agent in low calorie food formulations (Anon, 1974).

This work was carried out mainly to produce a low calorie apricot jam for diabetics using saccharin and xylitol as sweetening agents and to follow the physico-chemical properties and quality changes during storage at room temperature for prolonged periods of time. The effect of veltol in improving the taste was also studied.

MATERIALS AND METHODS

Materials

Ripe apricot fruit, suitable for making jam, was bought from the local market of Zagazig, Egypt. The sweeteners were sucrose, from The Egyptian Sugar and Distillation Co., saccharin, in the form of small tablets, and xylitol (crystalline powder of El-Kahira Pharmaceutical Co.). Low methoxyl pectin (Obi pektin), gelatin, calcium citrate (Merck), citric acid (Hoffman La Roche), sodium benzoate and veltol (Pfizer) were used as additives.

Methods

Preparation of jam

Apricot fruits were washed, air-dried, cut into halves and weighed. Eight types of jam were prepared as summarized in Table 1. Apricots and sugar were cooked in an open steel kettle for half-an-hour after boiling. The other additives, except veltol, were then added and the mixture was allowed to boil for a further 5 min to reach the required 70% Total Soluble Solids in the treatment containing the fruit and sucrose mixture. Time of processing of all treatments was equalized to obtain the same degree of cooking and to eliminate the effect of processing time alone on product quality.

The mixture of saccharin and xylitol was made by dissolving both in a small part of pre-boiled water and was added at the end of cooking. Veltol

TABLE 1
Weight of Materials (g) used for the Preparation of Different Types of Apricot Jam

Jam types	*Fresh apricot*	*Sucrose*	*Saccharin*	*Xylitol*	*Veltol*	*Pectin*	*Gelatin*	*Citric acid*	*Calcium citrate*	*Sodium benzoate*	*Total materials*
Sucrose pectin jam	600	600	—	—	—	9	—	3·75	6	1·054	1 219·80
Sucrose gelatin jam	600	600	—	—	—	—	12	3·75	—	0·960	1 216·71
Saccharin pectin jam	600	—	1·028	—	—	9	—	3·75	6	0·620	620·40
Saccharin gelatin jam	600	—	1·028	—	—	—	12	3·75	—	0·615	617·39
Saccharin xylitol pectin jam	600	—	0·616	240	—	9	—	3·75	6	0·792	860·16
Saccharin xylitol gelatin jam	600	—	0·616	240	—	—	12	3·75	—	0·805	857·17
Saccharin veltol pectin jam	600	—	1·028	—	0·18	9	—	3·75	6	0·613	620·57
Saccharin veltol gelatin jam	600	—	1·028	—	0·18	—	12	3·75	—	0·603	617·56

was added as late as possible at the lowest temperature feasible after cooking to minimize volatilization loss. The products were packed while hot in colorless glass 120-g jars covered with screw plastic caps and immediately closed. Samples were stored at room temperature (25–30°C) until analyzed after 0, 2, 4, 6 and 8 weeks.

Chemical analysis

The Total Soluble Solids contents of apricot fruit and jam were estimated at 25°C using a Zeiss refractometer. Total Solids were determined by drying at 70°C under vacuum. Reducing, non-reducing and total sugars were determined by the Lane and Eynon general volumetric method. Total acidity was determined by titration with 0·1N sodium hydroxide solution using phenolphthalein as an indicator; results were expressed as grams of citric acid per 100 g of sample. pH value of the jam was determined at 25°C using a HM 7 B pH meter according to the methods described by the Association of Official Analytical Chemists (AOAC, 1980). Ascorbic acid content was determined using 2,6-dichlorophenol indophenol for titration according to the method outlined by the Association of Vitamin Chemists (1947).

Calories requiring insulin were calculated on the basis of 1 g total sugars (reducing + non-reducing) ≡ 4·0 calories, as mentioned by Lawrence (1965).

Physical analysis

The viscosity of the jam (blended for 5 min) was measured according to the method of Aly (1973) using an Ostwald pipette. The apparent viscosity was measured at 25°C as the flow time, in seconds, through a 10-cm tube. Color index of jam is defined as the transmission per cent at 420 nm for carotenoids (El-Nakhal, 1969).

Organoleptic evaluation

Color and taste were evaluated by ten panel tasters. An average of scores was calculated. These qualities were scored using a scale ranging from 1 to 10. A score of 6 was considered to be the lower limit of acceptability (Notter *et al.*, 1959).

RESULTS AND DISCUSSION

The chemical composition of the edible portion of apricot (representing 82·6% of the total weight of the kernel) is shown in Table 2. The analysis was carried out immediately before processing into jam in order to study

TABLE 2
Chemical Composition of Apricot (Edible Portion)

Component	*Fresh apricot*
Moisture (%)	85·6
Total Solids (%)	14·4
Total Soluble Solids (%)	12·0
Reducing sugars (%)	2·50
Non-reducing sugars (%)	4·65
Total sugars (%)	7·15
Total acidity (as citric acid) (%)	2·22
Ascorbic acid (mg/100 g)	6·20
pH	3·41

the effect of processing and added components on the quality and stability of jam. Apricot contains 14·4% Total Solids and 12% Total Soluble Solids. The difference is mainly due to the insoluble pectin and fibers. The results agree with those previously reported (Anon, 1964; Sarhan *et al.*, 1971; Aly 1973), Total Soluble Solids in apricot ranging from 11·5% to 14·3% according to variety and stage of maturity. Apricot fruits contained 7·15% of their fresh weight of total sugars which constituted about 50% of the Total Solids content. The high citric acid content of apricot is responsible for its relatively low pH value.

Chemical properties of jam

Table 3 shows the changes that occurred in the chemical characteristics of apricot jam during storage for 8 weeks. The Total Soluble Solids in apricot jam ranged from 13% to 69·8%, depending upon the jam type. Jam containing saccharin as sweetening agent had 13%–14% Total Soluble Solids while that made with the saccharin and xylitol mixture contained 44%–45·5% with the lowest value when pectin was used as a thickening agent. The results indicate that there were no changes in the Total Soluble Solids of jam samples during storage time.

No appreciable changes in the total sugars and total acidity of jam occurred after storage for 8 weeks. The results obtained agree with those obtained by Heikal *et al.* (1964) and Sarhan *et al.* (1971).

There was a gradual decrease in the non-reducing sugars of jam while reducing sugars increased. The inversion of non-reducing sugars was higher when saccharin and/or the saccharin–xylitol mixture was used than sucrose in the presence of either pectin or gelatin (Table 4). This may be due to the higher total acidity of jam prepared using sweetening agents. Such acidity enhances the hydrolysis of sucrose in the apricot. Results also show

TABLE 3
Chemical Characteristics of Apricot Jam before (B) and after (A) Storage for 8 Weeks at Room Temperature

Jam types	*Chemical characteristics*							
	Storage	*Total soluble solids (%)*	*Total sugars (%)*	*Reducing sugars (%)*	*Non-reducing sugars (%)*	*Total acidity (citric acid) (%)*	*Ascorbic acid (mg/100 g)*	*Calories requiring insulin in 100 g*
Sucrose pectin jam	B	68·0	59·0	37·5	21·5	1·50	2·40	236
	A	68·5	59·1	43·9	15·2	1·53	1·55	236
Sucrose gelatin jam	B	69·0	59·5	39·3	20·2	1·53	2·50	238
	A	69·8	59·4	45·2	14·2	1·54	1·60	238
Saccharin pectin jam	B	14·0	8·60	5·00	3·60	2·50	4·60	34·4
	A	14·0	8·60	7·20	1·40	2·52	2·90	34·4
Saccharin gelatin jam	B	13·0	8·65	4·95	3·70	2·30	4·75	34·6
	A	13·3	8·65	7·10	1·55	2·30	3·00	34·6
Saccharin xylitol pectin jam	B	44·0	8·40	4·50	3·90	2·10	3·80	33·6
	A	44·5	8·40	6·90	1·50	2·10	2·00	33·6
Saccharin xylitol gelatin jam	B	45·0	8·59	4·80	3·79	2·12	3·72	34·4
	A	45·5	8·59	7·00	1·59	2·12	1·95	34·4
Saccharin veltol pectin jam	B	13·5	8·70	4·89	3·81	2·45	4·62	34·8
	A	13·7	8·72	7·30	1·42	2·44	2·68	34·9
Saccharin veltol gelatin jam	B	13·5	8·82	4·85	3·97	2·35	4·81	35·3
	A	14·0	8·83	7·40	1·43	2·34	2·22	35·3

TABLE 4
Changes in Reducing and Non-reducing Sugar Contents of Apricot Jam during Storage

Jam types	*Storage period (weeks)*				
	0	*2*	*4*	*6*	*8*
	I—Reducing sugars (g/100 g)				
Sucrose pectin jam	37·5	38·3	39·7	41·5	43·9
Sucrose gelatin jam	39·3	40·2	42·3	43·4	45·2
Saccharin pectin jam	5·00	5·9	6·3	7·0	7·2
Saccharin gelatin jam	4·95	5·3	5·8	6·6	7·1
Saccharin xylitol pectin jam	4·50	4·9	5·3	6·7	6·9
Saccharin xylitol gelatin jam	4·80	5·2	5·9	6·5	7·0
Saccharin veltol pectin jam	4·89	5·5	6·3	7·0	7·3
Saccharin veltol gelatin jam	4·85	5·6	6·2	6·9	7·4
	II—Non-reducing sugars (g/100 g)				
Sucrose pectin jam	21·5	20·8	19·3	17·5	15·2
Sucrose gelatin jam	20·2	19·4	17·2	16·3	14·2
Saccharin pectin jam	3·60	2·70	2·40	1·70	1·40
Saccharin gelatin jam	3·70	3·35	2·85	2·05	1·55
Saccharin xylitol pectin jam	3·90	3·50	3·10	1·70	1·50
Saccharin xylitol gelatin jam	3·79	3·40	2·70	2·09	1·59
Saccharin veltol pectin jam	3·81	3·20	2·45	1·70	1·42
Saccharin veltol gelatin jam	3·97	3·22	2·63	1·94	1·43

that there was a decrease in vitamin C content of jam during storage (Table 3). This may be due to the fact that oxidation of vitamin C occurs by light and air.

The caloric value of jam prepared with sweetening agents did not exceed 14·8% of that of jam prepared with sucrose. Saccharin was reported to yield calories during its digestion equal to that of glucose but it required no insulin (FAO, 1964). Therefore, such jams could be commercially prepared and distributed for consumption by diabetics without danger.

Physical properties of jam

Table 5 shows that viscosity was highest in jam prepared using saccharin and veltol. Less viscosity is noticeable with saccharin–xylitol and was least with sucrose alone. Moreover, pectin was found to increase viscosity much more than gelatin. This may be due to the calcium low methoxy pectate formed as a result of adding calcium citrate during processing of apricot jam. When gelatin was added as a thickening agent for jam containing saccharin, the viscosity value was low compared with that made with pectin. However, there was a gradual increase in the viscosity (flow time)

TABLE 5
Changes in Flow Time (in seconds) and Color Index (Transmission % at 420 nm) of Apricot Jam During Storage

Jam types	*Storage period (weeks)*				
	0	*2*	*4*	*6*	*8*
			I—Flow time		
Sucrose pectin jam	225	230	240	250	[a]
Sucrose gelatin jam	200	205	210	220	225
Saccharin pectin jam	220	230	235	235	240
Saccharin gelatin jam	50	55	65	65	70
Saccharin xylitol pectin jam	225	225	230	240	[a]
Saccharin xylitol gelatin jam	140	145	150	160	160
Saccharin veltol pectin jam	225	230	240	250	[a]
Saccharin veltol gelatin jam	55	60	60	65	70
			II—Color index		
Sucrose pectin jam	100	90	83	79	79
Sucrose gelatin jam	98	91	85	80	80
Saccharin pectin jam	92	85	82	81	80
Saccharin gelatin jam	92	87	80	79	75
Saccharin xylitol pectin jam	87	82	82	81	81
Saccharin xylitol gelatin jam	89	83	83	83	82
Saccharin veltol pectin jam	93	90	90	89	89
Saccharin veltol gelatin jam	95	92	91	91	90

[a] The jam was too viscous to be measured.

in all jam samples during storage. This may be due to the effect of acidity on the formation of low methoxy pectin as a result of the hydrolysis of apricot pectin. The results are in agreement with those reported by Rouse *et al.* (1956), Mosse & Iranzo (1960) and Luh & Daster (1966) who found that the syrup viscosity of canned apricot increased gradually during storage.

Table 5 shows that jam prepared with sucrose had the highest color index value (as carotene content) while that prepared with the saccharin–xylitol mixture had the lowest value. On the other hand, color destruction was increased with increasing storage time in all treatments. This could be due to Maillard reactions and oxidation of ascorbic acid according to Aly (1973).

The mean scores of organoleptic characteristics of apricot jam samples are summarized in Table 6. The results show that the color and taste of the jam containing saccharin compared favourably with those of the control. However, during storage an unpleasant after-taste was also noted by panelists.

TABLE 6
Organoleptic Evaluation of Apricot Jam

Jam types	*After processing*			*After storage*		
	Score out of 10		*Total score*	*Score out of 10*		*Total score*
	Color	*Taste*		*Color*	*Taste*	
Sucrose pectin jam	10	10	20	10	10	20
Sucrose gelatin jam	10	9·8	19·8	10	9·5	19·5
Saccharin pectin jam	6·5	7·9	14·4	6·2	7·5	13·7
Saccharin gelatin jam	6·9	8·0	14·9	6·4	8·0	14·4
Saccharin xylitol pectin jam	10	10	20	10	9·8	19·8
Saccharin xylitol gelatin jam	10	9·9	19·9	10	9·6	19·6
Saccharin veltol pectin jam	9·4	9·5	18·9	9·3	9·5	18·8
Saccharin veltol gelatin jam	9·2	9·3	18·5	9·3	9·0	18·3

The addition of xylitol or veltol with saccharin markedly improved color and taste of the product. On the other hand, no differences in jam color and taste were noticed during storage.

A diabetic can safely consume about 200 and 450 g daily of apricot jam sweetened with saccharin and saccharin–xylitol mixture, respectively (based on experimentally verified limits of 5–15 mg saccharin per kilogram body weight). Such rates fall in the range of the ADI (Acceptable Daily Intake) recommended by FAO/WHO (1983*b*).

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