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EFFECT OF SUBSTITUTING SUCROSE BY GLYCYRRHIZIN ON THE CHEMICAL, SENSORY PROPERTIES AND FUNGAL GROWTH ON STRAWBERRY JAM .

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ABSTRACT

Non-calorie sweteners have revolutionized the food industry . The chemcical , sensorey properties and fungal growth on strawberry jam manufactured by glycyrrhizin (non-calorie sweetner) instead of sucrose were investigated , using three jam treatments i.e.:-"a" without any chemical addition, "b" with 0.3% citric acid and 0.1% sodium benzoate and "c" with 100 ppm potassium metabisulphite .

Data indicated that strawberry fruits are suitable for making low-calorie jam, it has relatively low sugars content, it was 49.1 % as total sugars and 8.6 % as non reducing sugars . There are high losses of ascorbic acid and anthocyanin as a result of jam processing . The loss was more pronunced for the untreated strawberry jam .

On the other hand the three treatments of jam have excellent grade in overall acceptability of sensory properties , immediately after processing.

Each treatment was divided into two parts, the first was stored at room tempreature and the second was stored at 6°C. The obtained results during storage indicate that there was much loss in ascorbic acid and anthocyanin especialy in treatment "a". While the combine of 0.3% citric acid and 0.1% sodium benzoate or 100 ppm metabisulphite protect ascorbic acid and anthocyanin, especially those stored at 6°C .

Fungal growth appeared after one month in treatment "a" stored at room temperature or at 6° C. In treatment "b" it appeared after 3 months at room temperature and after 6 months at 6°C. The samples of treatment "c" were free from the fungal growth wether they stored at room temperature or at 6 °C for 12 months .

It can be concluded that for manufacturing low calorie jam glycyrrhizin can be safley used as a non-nutritive natural sweetener . The low-calorie jam can be stored for one year at room temperature when using 100 ppm potassium metabisulphate . Using the combine of 0.3% citric acid and 0.1% sodium benzoate preserve the jam for 3 months at room temperature and for 6 months at 6 °C.

For manufacturing low-calorie jam without any chemical preservation,it must be consumed within one month when stored at room temperature or at 6°C .

Keywords : Glycyrrhizin, low-calorie jam, strawberry jam, jam preservation and sotrage condition of jam .

INTRODUCTION

When artificial sweetners were introduced in the first diet soft drinks in the late 1950, consumption was negligible . As consumers' attention, however, turned toward low-calorie foods, consumption patterns showed increasing trends.

Low calorie jam is made with non-nutritive sweteners such as glycrrhizin which extracted from the licorice roots (Abd El-Aal, 2002).Glycyrrhizin is a non-mutritive sweetener , non-toxic component, safe

within the Food and Drug Administration (FDA) list of natural flavoring compounds and there is no recognition of Acceptable Daily Intake (ADI) . Glycyrrhizin is used extensively in the Japanese food industry as a flavoring agent to enhance the flavor of cocao and chocolate products . The most important is that glycyrrhizin, has sweetening power 100 times of sucrose . (Dziezak, 1986, Abou Zaid , 2000 and Zena , 2000).

Glycyrrhizin is suitable for low-calorie jam productoin because it is best within the pH ranged from 3 to 5 and it readily dissolves in hot or boiling water (Abd El-Aal, 2002) . Flavorful fruits are best for jam because the fruit flavor is diluted by large proportions of sugars, strawberry is considered flavorful fruits, on other hand, strawberry has low sugars content, for this reason, strawberry fruits are the best fruits for producing low-calorie jam. All underripe fruits have more pectin than ripe fruits, for this, some methods used 50% underripe and 50% ripe to make high quality jam. The added pectin method is preferred for making jam by using fully ripe fruits. Jam made with added pectin requiers less cooking time and has more natural fruit flavor(Martha , 2000) .

Polydextrose is nonsweet component which improves mouth feel and product texture without affecting sweetness , it is low calorie component , used as a multipurpose food additive and it can be used as a bulking agent to rise T .S.S of jam instead of sugars. It can be used as formulation aid and texturizer (Figdor and Rennhard, 1981) . Polydextrose is recognized as safe within the FDA's List of natural compounds , it is nontoxic and non carcinogen to human (Dziezak, 1986 and Zena, 2000) .

The present work was carried out to study the chemical and sensory properties and fungal growth on low calorie strawberry jam during storage after different preservation treatments i.e. :

a.Addition of 0.3% citric acid and 0.1% sodium benzoate .

b.Addition of 100 ppm sodium metabisulphites .

and using two storage temperature degrees i.e. room temperature (28°C ± 1) and refrigerator temperature (6 °C) .

MATERIALS AND METHODS

1- Materials :

a- Strawberry (*Fragaria Vesca*) Rose family *(Rosaceae)* Strawberry fruits were obtained from the local markets at Alexandria. Fruits were of good shape, evently coloured and full ripe .

b- Glycyrrhizin it was obtained from licorice roots by extraction with citric acid (Abd El-Aal, 2002) .

c- Polydextrose it was bought from pfizer campany, Cairo .

d- Pectin : Apple pectin type Ns-150 Us-SAG of the Egyptian Chemical Stores, Alexandria was used .

2- Methods :

(A) Analytical methods :

- Gross chemical composition i.e. moisture, protein, fat, ash. fiber, sugars (reducing , non reducing and total sugars), ascorbic acid and acidity were determined as recommended by A.O.A.C (1990) .
- Total soluble solids T.S.S. % were determined by refractometer HSR 500.
- Pectin content : was estimated as reported in pearson (1976) .
- Anthocyanin : was determined as reported in Ranganna, (1977).

(B) Technological methods :

- **Jam production** : It was prepared from full ripe fruits of dark red colour and slightly soft texture .

1- Control strawberry jam :-

One Kg of fruits were dumped into the kettle with one Kg of sucrose mixed with 6.5 gm pectin and the mixture was bolied. twenty ml of lime juice were added at the end of the cooking to adjust pH to 3 since lime juice is prefered than citric acid in adjusting pH (Omar and El-Ahwah 2002) .Heating was continued until the soluble solids content amounted to 70% . Jam was packed in jars made from tempered glass to resist high temperatures. Jars were filled, leaving ¼ inch headspase. Lids were tightly closed and jars were heated at 100 °C for 25 min.

2- Low calorie strawberry jam :-

glycyrrhizin equivalent = 100 times of sucrose (sweetening power)

$$\text{Amount of glycyrrhizin} = \frac{\text{Sucrose weight}}{\text{Glycyrrhizin power}} : \frac{1000}{100} = 10 \text{ gm}$$

Amount of polydextrose = sucrose weight – glycyrrhizin weight .
= 1000 – 10 = 990 gm (Safwat , 1992)

One kg fruit as reported above in the control jam were mixed with 990 gm polydextrose and 6.5 gm pectin . Ten grams of glycyrrhizin were added in the last minute before the end of cooking to avoid the damage of glycyrrhizin if it is heated for too long time . Another samples of jam was also prepared with fruits mixed with 0.3% citric acid and 0.1% sodium benzoate (Treatment b) and the other samples were mixed with 100 ppm of potassium metabisulphite (Treatment c) .

The keeping quality of low calorie strawberry jam was tested during 12 month's storage .Half of the samples were stored at room temperature(28±1° C) and the other half in cold stroage at 6 °C. Analysis were done after preparation and after 1,3,6,9 and 12 months .

C- Sensory evaluation :-

Low-calorie strawberry jam was subjected to the sensory evaluation as described by king, *et al.*(1995) . Color, taste, odor and texture were assessed by ten panelists working in Food Technology laboratory in Sabahia

Horticultural Research Station, Alexandria. A score from 100 to 40 was applied for this evaluation where from 40 to less than 50 is poor, from 50 to less than 70 is fair, from 70 to less than 80 is good and from 80 to 100 is exellent , as reported by Notter, *et el.*(1970) .

D- Microbiological examinations :-

Detection of fungi :-

Fungi were assessed using the dilution plate method as dsecribed by Moubasher , *et al* (1972) .

E- Statistical methods :-

Data were recorded for the personal computer using specific program function for personal computer (SPF/PC) and Statistically analyzed according to Harvey computer program (1990) .

RESULTS AND DISCUSSION

A- Chemical composition of fresh strawberry fruits :-

Results in Table (1) indicate that strawberry fruit has relatively low sugar content (49.1%) , and low pectin content (3.14%) , which is not enough to make high-quality jam .Our results are in agreement with those reported by Martha,(2000) who reported that most jams require added pectin when made from fruits which have not enough natural pectin to make high-quality jam such as strawberry fruits.

The red color in strawberry fruits is due to anothocyanin content it is 181.4 mg/100g dry wieght. Similar statements were reported by Hyvonen and Törmä , (1983) who found that the content of anthocyanin in strawberry fruit is about 195 µg/g fresh fruit .

Table(1):Chemical composition of fresh strawberry (on dry weight basis) .

Component	Strawberry fruit
Moisture %	89.80
Protein %	8 .82
Fat %	1.18
Fiber %	14.80
Ash %	4.90
Total sugras %	49.10
Reducing sugars %	40.50
Non-R.sugars %	8.60
Acidity %	5.78
Total pectin %	3.14
Ascorbic acid (mg/100g)	318.60
Anthocyanin (mg/100g)	181.40

B- Changes during processing of jam :-

1- Chemical properties :-

Acidity , a scorbic a cid and anthocynin were used as parameters to evaluate the quality of strawberry jam .

The effect of citric acid, sodium benzoate and potassium metabisulphite on the chemical properties of the jam were studied .

Table 2: Changes in acidity, ascorbic acid and anthocyanin in different treatments of strawberry jam . (on dry weight basis) .

Jam / Components	Control	Low calorie jam treatments		
		a	b	c
Moisture %	25.0	25.0	25.1	25.2
Acidity %	7.10	7.79	9.28	7.80
Ascorbic acid (mg/100g)	32.5	34.8	65.1	70.2
Anthocyanin (mg/100g)	85.6	89.8	98.9	130.2

Control : jam prepared with sucrose

Treatments of low calorie jam prepared with glycyrrhizin are :-

a : low calorie jam prepared without any chemical addition .

b: low calorie jam prepared w ith 0 .3% c itric a cid a nd 0 .1% sodium benzoate .

c: low calorie jam prepared with 100 ppm. potassium metabisulphite .

From Table (2) it could be noticed that the acidity content increased in all treatments . This increase is due to the addition of lime juice in all the different treatments . The acidity in low calorie jam is higher than that in the control jam, this is due to the addition of ploydextorse contains small amounts of sorbitol and citric acid (Figdor and Rennhars ; 1981) . The highest acidity content i s shown i n t reatment (b) this is due to the addition of 0.3 % citric acid. From the same Table (2) it can be also noticed that there is high degradation of ascorbic acid especially in the untreated jams. The loss of ascorbic acid percent reached 90% as a result of heat process and the ascorbic acid oxidation . Citric acid is considered antioxidative agent and it protects ascorbic acid from destruction, this is noticed in treatment (b) in which the loss of ascorbic acid percent is 80% .

The highest content of ascorbic acid was demonsrated in the persence of p otssium m etbisulphites , t his i s m ay b e d ue t o t he p rotective effect of sulphites against oxidation, the loss of ascorbic acid percent is 78% .These results agree with kozup, *et al.* (1980) who found that sodium bisulphite provided a great stabilizing effect on the chemical properties of jam.

It is clear from the data in Tables (1and 2) that the anthocyanins of both the treated and the untreated strawberry jam decreased during processing , but the decrease was more pronounced for the untreated jam. The anthocyanin loss percent ranged from 52.8 to 50.5% for the untreated jam and ranged from 45.5 to 28.2% for the treated jam.The least loss was observed when potassium metabisulphite was added .

2- Sensory evaluation :-

The color of strawberry jam prepared with sucrose is less acceptable, this is due to the degradation of anthocynain and may be also due to Millard reaction. While the Millard reaction does not take place in low-calorie jam containing glycyrrhizin .These results agree with those of Dziezak, (1986) who reported that Millard reaction does not appear in dibetic jam .

Results in Table (3) indicate that color of jam was changed during processing, this is due to the degradation of anthocyanin . The jam with sulphite treatment "c" has the best color among the three tested jam treatments . All the jam treatments were acceptable by taste and they are considered mildly pleasant, while the control jam has the best taste .

Table (3) : Mean ± SD of sensory evalutaion of different low calorie strawberry jam treatments (a,b, and c) compared with control.

Jams Parameters	Control	Low calorie jam treatments		
		a	b	c
Color 20	15 ± 0.02	16 ± 0.12	18 ± 0.11	19 ± 0.05
Odor 20	19 ± 0.11	16 ± 0.22	17 ± 0.10	17 ± 0.05
Taste 20	19 ± 0.09	15 ± 0.15	17 ± 0.08	17 ± 0.13
Apperance 20	18 ± 0.19	18 ± 0.24	18 ± 0.25	18 ± 0.18
Texture 20	18 ± 0.03	18 ± 0.14	18 ± 0.18	18 ± 0.17
Overall acceptibility (100)	89	83	88	89
Grade	Excellent	Excellent	Excellent	Excellent

grades : from 80 to 100 excellent

Data in Table (3) indicate that the texture of all jam treatments is highly acceptable, this may be due to the ploydextrose added to the low-calorie jams, which is considered texturizer and multipurpose food additive, and also maybe due to the addition of external apple pectin to the jam. All jam treatments have more natural flavor, this is due to the using of fully ripe fruits in preparing the jam. From Table (3) it can be concluded that glycyrrhizin can be used as sweetening agent instead of sucrose for preparing low-calorie jam with excellent grade of overall acceptibility .

C- Changes during storage :

1- Chemical properties :-

Changes in ascorbic acid , acidity and anthocyanin in low-calorie jam during storage period for 12 months were investigated .

Table (4): Changes in moisture and acidity content of low calorie jam treatments during storage (on dry weight basis) :

Storage period (mon.)	Moisture %						Acidity %					
	Room temperature			Refrigerator			Room temperature			Refrigerator		
	a	b	c	a	b	c	a	b	c	a	b	c
Zero time	25.0	25.1	25.2	25.0	25.1	25.2	7.79	9.28	7.80	7.79	9.28	7.80
1	25.2	25.1	25.0	25.1	25.2	25.2	7.85	9.89	7.90	7.95	9.28	7.80
3	-	25.3	25.2	-	25.1	25.2	-	9.89	7.98	-	9.49	7.80
6	-	-	25.1	-	25.2	25.2	-	-	7.98	-	9.89	7.80
9	-	-	25.3	-	-	25.2	-	-	7.99	-	-	7.82
12	-	-	25.3	-	-	25.2	-	-	7.99	-	-	7.82

As obvious in Table (4) there is no significant effect of storage months or storage tempretures on moisture content in all treatments , it is almost constant during storage period .

It is shown also in Table (4) that there is an increase of acidity during storage especially at 28 °C, this increase is attributed to formation of Co_2 .On the other hand, no changes in acidity were observed during storage the samples at 6 °C . Opposite results were obtained by Garcia Viguera, *et al* . (1999)who reported that there is no change in acidity for strawberry jam during storage at 20 or 37° C.

From Table (5) it is clear that dramatic loss in ascorbic acid and anthocyanin was noticed in treatment (a) stored at room temperature or at 6 ° C while treatment "c" led to high residual content of ascorbic acid, this is mainly due to the act of metabisulphite which protect contents of ascorbic acid and anthocyanin from degradation comparing to treatment (a) .

Table (5): Changes in Ascorbic acid and anthocyanin content of low calorie jam treatments during storage (on dry weight basis)

Storage period (mon.)	Ascorbic acid "mg/100g"						Anthocyanin "mg/100g "					
	Room temperature			Refrigerator			Room temperature			Refrigerator		
	a	b	c	a	b	c	a	b	c	a	b	c
Zero time	34.8	65.1	70.2	34.8	65.1	70.2	89.8	98.9	30.2	89.8	98.9	130.2
1	Zero	32.2	56.6	20.1	54.2	63.4	52.3	72.3	121.2	60.2	90.8	130.2
3	-	30.5	55.1	-	53.1	63.3	-	70.1	110.3	-	90.1	130.3
6	-	-	53.4	-	53.0	60.9	-	-	10.1	-	90.1	130.2
9	-	-	52.0	-	-	60.0	-	-	108.0	-	-	128.2
12	-	-	50.1	-	-	60.0	-	-	105.0	-	-	120.2

Analysis of variance (ANOVA) of Tables (4 and 5)

Source of variance	Degree of freedom	F.value			
		moisture	Acidity	Ascorbic acid	Anthocyanin
Storage time	5	0.12	2.12*	4.15*	6.25*
Storage temp.	1	0.20	4.28*	5.01*	8.34*

* $p < 0.05$

The lower temperature seemed to protect ascorbic acid and anthocyanin . These results are in agreament with those reported by Kozup, *et al* (1980) and Spayd and Morris (1981) .The statistical analysis of our results in Table (4,5) reveal that there is significant effect of storage time and temperature on the asccobic acid, acidity and anthocyanin contents of low calorie strawberry jam .

2- Changes in sensory evaluation during storage :-

The keeping quality of low-calorie strawberry jam were tested during 12 months storage either at room temperature or in cold storge (6° C) to the sensory properteis as overall acceptibility .In the light of the data given the Table (6) the untreated low-calorie jam (treatment a) after one month of storage at room temperature or 6°C was regarded as good and excellent degree respectively. On the other hand, the jam treated with citric acid and sodium benzoate (treatment b) stored at room temperature for three months or at 6 °C for six months was judged to be good and excellent degree respecively.

Table (6) : Mean ± of sensory evaluation of different low-calorie strawberry jam during storage for 12 months .

Treatments	Room temperature(28±1) °C			Refrigerator (6 °C)		
Srorage time	a	b	c	a	b	c
Zero time	83±1.31	88 ± 0.51	89±0.8	83±1.31	88±0.51	89±0.80
1	75±1.81	79±1.92	82±0.1	80±1.20	88±0.12	89±0.31
3	-	75±1.83	82±0.5	-	86±0.19	89±0.25
6	-	-	81±0.2	-	80±0.18	89±0.12
9	-	-	81±0.3	-	-	85±0.21
12	-	-	81±0.2	-	-	85±0.4

Data in Table (6) also shows that the jam treated with 100 ppm potassium metabisulphite and stored at room temperature or at 6 °C is the best one in the overall acceptability, it has excellent degree during all the 12 months storage period .

3- The effect on the fungal growth :

Results in Table (7) indicate that all samples are free from fungal growth immediately after manufacturing of jam, this is due to the heat process (100 °C for 25 min) , and the addition of 0.3% citric acid and 0.1% sodium benzoate to the jam before the autoclaving which killed the the fungal growth, this is due to the effect of citric acid and benzoate as in treatment "b" also fungicidal action was occurred in treatment "C" due to the presence of metabisulphite . Table (7) also showed that fungal growth appeared in strawberry jam without preservatives (treatment a) in the second month during storage whether at room temperature and 6 °C.

Table (7) : Effect of storage time and temperature on the fungal growth of low-calorie strawberry jam .

Srorage time (mon.)	Room temperature(28±1) °C			6 °C		
	a	b	c	a	b	c
Zero time	-	-	-	-	-	-
1	-	-	-	-	-	-
2	+	-	-	+	-	-
3	+	-	-	+	-	-
4		+	-		-	-
5		+	-		-	-
6			-		-	-
7			-		+	-
8			-		+	-
9			-			-
10			-			-
11			-			-
12			-			-

(-) : free from fungal growth (+) : There are fungal growth

These results are in agreement with those reported by Martha , (2000) who reported that non nutritive strawberry may be substituted for sugar . However, the jam wether stored at room temperature or refrigerated , should be used within 2 to 4 weeks .

From Table (7) it could be also observed that the fungal growth was appeared in treatment (b) only after 3 months during storage at room temperature and after 6 months at 6°C. On the other hand, strawberry jam in treatment "c" was found free from fungal growth during storage for 12 months at both room temperature and 6 °C.

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تأثير استبدال السكروز بالجلسريزين على الصفات الكيماوية و الحسية و النموات الفطرية على مربى الفراولة.

فاطمة الزهراء على عبد العال
قسم الحاصلات البستانية – معهد بحوث تكنولوجيا الأغذية مركز البحوث الزراعية .

فى هذا البحث تم دراسة الصفات الكيماوية و الحسية و النموات الفطرية لمربى الفراولة المصنعة بالجلسريزين كمُحلى طبيعى بدلاً من السكروز . نتائج هذا البحث تشير إلى أن الفراولة مناسبة لعمل المربى منخفضة السعرات نظرا لاحتوائها على محتوى منخفض نسبياً من السكر و هو ٤٩,١ % على أساس وزن جاف كسكريات كلية و تشمل نسبة بسيطة منها كسكريات غير مختزلة (سكروز) و هى حوالى ٨,٦% إلا أنها تعتبر من الفاكهة المنخفضة فى البكتين حيث محتواها من البكتين كان ٣,١٤ (على أساس وزن جاف) و هذا غير كافى لعمل مربى ذات جودة عالية و لذلك تم فى هذا البحث إضافة بكتين خارجي للحصول على مربى عالية الجودة .و من جهة أخرى وجد فقد كبير فى محتواها من حمض الأسكوربيك والأنثوسيانين كنتيجة تصنيعها إلى مربى ،و هذا الفقد كان أكثر وضوحا للمعاملة "a" و هى التى لم تعامل بأى من المواد الحافظة المستخدمة فى باقى المعاملات مثل استخدام حمض الستريك ٠,٣% مع بنزوات الصوديوم ٠,١% كما فى المعاملة "b" أو ميتابيسلفيت البوتاسيوم ١٠٠ جزء فى المليون كما فى المعاملة "c" .

و لقد وجد أن جميع المعاملات المصنعة لمربى الفراولة منخفضة السعرات على درجة ممتازة من ناحية التقبل العام للصفات الحسية و ذلك بعد تصنيعها مباشرة .و من النتائج المتحصل عليها أثناء التخزين لوحظ فقد كبير لحمض الإسكوربيك و كذلك للأنثوسيانين و خاصة فى المعاملة "a" ، بينما وجد أن استخدام حمض الستريك وبنزوات الصوديوم كما فى المعاملة "b" أو ميتابيسلفيت البوتاسيوم كما فى المعاملة "c" يعتبرا حماية لحمض الأسكوربيك والأنثوسيانين من الأكسدة و الفقد و خاصة عند التخزين على درجة حرارة ٦° م . أوضحت النتائج أيضا ظهور النموات الفطرية بعد الشهر الأول فى المعاملة (a) المخزنة على درجة حرارة الغرفة أو المخزنة على درجة ٦ م ، أما فى المعاملة (b) فظهرت هذه النموات الفطرية بعد ٣ شهور من التخزين على درجة حرارة الغرفة و بعد ٦ أشهر عند التخزين على درجة حرارة ٦° م . أما المعاملة "c" فإنها وجدت خالية تماما من النموات الفطرية سواء المخزنة على درجة حرارة الغرفة أو على درجة حرارة ٦ م لمدة ١٢ شهر .

و من خلال هذه الدراسة يمكن استنتاج أنه لتصنيع مربى منخفضة السعرات يمكن استخدام الجلسريزين بأمان كمحلى طبيعى عديم السعرات و يمكن تخزينها لمدة عام على درجة حرارة الغرفة بعد إضافة ١٠٠ جزء فى المليون ميتابيسلفيت البوتاسيوم ووجد أن استخدام حمض الستريك ٠,٣% وبنزوات الصوديوم ٠,١% يحفظ المربى ثلاث شهور على درجة حرارة الغرفة و يمكن زيادة مدة الحفظ إلى ٦ شهور عند تخزينها فى الثلاجة ، بينما يمكن تصنيع مربى منخفضة السعرات بدون أى إضافات كيماوية أو مواد حافظة بالاعتماد على التسخين الابتدائى و حدوث الخلخلة وإزالة الهواء بالبرطمان و التعقيم بعد القفل (١٠٠° م لمدة ٢٥ دقيقة) و كذلك زيادة المواد الصلبة الكلية إلى ٦٥% بإضافة البولى ديكستروز كمادة مالئة ويفضل استهلاك هذه المربى خلال شهر سواء خزنت على درجة حرارة الغرفة أو فى الثلاجة .