Egyptian Journal of Agricultural Research

ORIGINAL ARTICLE

Egypt. J. Agric. Res., (2020), 98 (1), 11-22

Food Technology

MANUFACTURE OF MIXED JAMS USING NATURAL SOURCES OF POWERFUL ANTIOXIDANTS AND IRON

ABDEL-MALAK G. A., MOUSSA M.E.M.AND El-GENDY MANAL A.

Department of Horticultural Crops Technology Research, Food Technology Research Institute, Agricultural Research Center, P.O. Box 12619, Giza, Egypt

(Manuscript received 20 October 2019)

ABSTRACT

This investigation aims to manufacture some mixed jams enriched with antioxidants and iron by using acerola and tomato as source of powerful antioxidants to reduce trivalent of iron to divalent which favors its bioavailability in human body. Acerola and tomatoes were added to mixes containing figs, dates, apricot and strawberry and the final mixes were supplemented with (5gm/100gm) spirulina algae as a natural source of iron. Also, these mixes were fortified with (3mg Fe/100gm) ferrous gluconate. The carbohydrate content of ranged from 63.13 to 66.41 g/100 g for mixes containing 50% date and 50% apricot jams, respectively, while, the ash content ranged between 0.25g/100 g to 0.74 g/100 g for mixed jam containing 50% strawberry and date. Mixed jam containing 50% strawberries had highest amount of total phenolics (640.32 mg GAE/100 g). On the other hand, mixed jam containing 50% fig recorded the lowest content of total phenolics (281.03 mg GAE/100 g). Ascorbic acid of mixed jams was in the range of 83.07 to 126.52 mg /100 g. Meanwhile, the highest content of total carotenoids showed with apricot mix jam (71.18 mg /100 g) and mix jam containing fig recorded the lowest content (48.37 mg /100 g). Consequentially, the highest inhibition percent of antioxidant activity was (78.30%) for mix jam containing strawberry). The protein content of dried spirulina algae was 61.48%), while, the total carbohydrate, total lipids and ash content were 19.09, 4.63 and 6.78%, respectively. Also, the total carotenoids were 469.13 mg /100gm. On the other hand, spirulina algae had high content of iron (34.07 mg /100gm). Twenty-three phenolic compounds were identified for all tested mix jams namely protocatechuic, chlorogenic, catechin and other compounds; these phenolic compounds are interesting owing to their health benefits. Finally, mixed jams in our study had high content of iron as a result of adding spirulina algae and ferrous gluconate. The date mix jam had high content of iron (6.21mg /100gm) apricot mix jam was low iron content (5.67mg /100gm).

Key words: Mixing Jams, Enrichment, Acerola, Tomato, Iron bioavailability, Spirulina algae, Antioxidant, Sensory evaluation

INTRODUCTION

Improvement of food products with micronutrients is a fundamental component of systems against healthful insufficiencies, of iron inadequacy, particularly, of populace inside creating nations. Adding of one micronutrient must be done dependent on logical investigates, with the goal that its concentration in product to be ideal for amendment of nutritional insufficiency, and in a similar time to keep the sensorial properties of the product (appearance, taste, smell, color) (**Berger, 2003).**

Although, fruit of processed have low content of iron, nutritionists prescribe to enhancement of the eating routine treatment with iron to indemnity the estimation of a food product, as iron source, is affected substantially more by synthetic condition of this component than of its absolute iron substance. The iron was added to nourishment must be high solvency; simple ionization and ferrous valence are properties which increment iron absorption grade. If there should arise an occurrence of organic products, due to the content of ascorbic acid, reduce of trivalent to bivalent iron, which appropriate it's in human body bioavailability **(Mogos, 1997).**

Metal ions, for example, iron can instigate DNA harm by oxygen reaction species and oxidative pressure. Vitamin C is one of the most generally expended consume antioxidant affective factors in the world. Recently, fruits particularly acerola *Malpighia glabra L.,* which cultivate in Brazil. Acerola is considered as an utilitarian natural product because of its high of antioxidant and phenolic compounds content for that, for that its used to prevent the human from many diseases or as adjuvant in treatment methodologies **(Horta et al., 2016).**

Supplementation of apricot and plums fruits with iron which concentrated products by using two levels (4mg/100 g and 6.5 mg/100 g) final products of ferrous sulfate, ferrous lactate and ferrous gluconate were individually. Expanding of iron bioavailability in the human body and, in a similar time, affirmation of an acidity of samples based concentrated product has been ended by including of ascorbic acid in their consumption. Fruits were concentrated and supplemented with iron were analyzed from sensorial, biochemical, and microbiological purpose of perspectives. The pre-owned fortification materials don't adjust product sensorial attributes (appearance, colour, taste and smell), of the product in correlation with control sample (jams non-supplemented with iron). "Plum jam supplemented with iron", together with other two products iron supplementation ("Iron supplemented bread" and "Cake with dried fruits products supplemented with iron") have been clinically tested. The product was utilized as an eating diet partaking 24 children, 16 boys and 8 girls, aged 3 to 12 years, within30 days. Following clinical testing it was showed that these products statistically significant and positively effective of the value of circulating iron in the case of children with iron deficiency ferriprive anemia **(Catană et al., 2013)**.

The usage of algae especially Spirulina, as a practical nutrient was proposed decades back because of the way that it isn't just a protein-dense nutrient source, but since its amino acid profile is

considered starting at high biological value protein content. Spirulina gives essential fats (e.g., gamma-linolenic oleic acids), corresponding to low substance nucleic acids. It additionally has an incredibly high substance of vitamin B12, is important source of beta-carotene, iron, calcium and phosphorous. In addition, Spirulina has additionally demonstrated to have best acceptability as of its organoleptic properties (in this way making it a potential possibility for food or a sustenance supplement) since it has not shown neither acute nor chronic toxicities, which making it protective for human utilization **(Gutiérrez-Salmeán et al., 2015).**

Spirulina algae growth had a higher protein, fat and dietary fiber substance; additionally, it contains high content of iron. Yogurt enhanced with 0.25% of Spirulina algae gave closer results with control sample for textural and sensory evaluation. Accordingly, the supplementation of these products will adequately decrement diseases related with nutritional deficiencies **(Barkallah et al., 2017).**

Algae are progressively being consumed for useful advantages beyond the conventional contemplations of nutrition health. There is considerable evidence for the health benefits of algal-derivedfood products **(Neher et al., 2018).**

The aim of this investigation is to use of rich antioxidant fruits such as acerola and tomato to manufacture some mixing jams i.e., mix jams with 50% fig, date, apricot and Strawberry were added to 25% acerola, 25% tomato and 5gm spirulina algae, fortified by antioxidants and iron by using spirulina algae which considered as a source of iron. Also, ferrous glutamate for preparing mixing jams was undertaken.

MATERIALS AND METHODS

Preparation of jam fortified with iron

Vegetables and fruits which were used for preparing jam namely, acerola, tomato, fig, apricot, date and strawberry were obtained from Agricultural Research Center, Horticultural Research Institute, Giza, Egypt and mixed as follows:

Samples were washed and separate of acerola and date seeds also tomato was blended and separate peels and seeds from tomato juice.

1. Mixed Jam,50% fig, 25%acerola, 25% tomato, 5gm spirulina algae and 3mg Fe/100 gm ferrous gluconate.

2. Mixed Jam, 50% date, 25%acerola, 25% tomato and 5gm spirulina algae, 3mg Fe/100 gm ferrous gluconate.

3. Mixed Jam, 50% apricot, 25%acerola, 25% tomato, 5gm spirulina algae and 3mg Fe/100 gm ferrous gluconate.

4. Mixed Jam, 50% Strawberry, 25%acerola, 25% tomato, 5gm spirulina algaeand 3mg Fe/100 gm ferrous gluconate.

Experiments performed for achievement of fruit-based concentrated products, fortified with spirulina algae and ferrous glutamate as source of iron. Four mixed jams were prepared as follows: 200 gm of fig (mix 1), date (mix 2), apricot (mix 3) and strawberry (mix 4) and added of 100gm tomato and 366 gm sugar for all mixes with 1.8 gm pectin and citric acid was used for adjusting pH values for proper gelatinization of pectin. Four mixed the large part of sucrose (266 gm) and citric acid was mixed and cooked. Pectin was mixed with part of sucrose, 100gm acerola fruit, 5gm spirulina algae and 3mg Fe/100 gm ferrous gluconate were added at final stage of the cooking jams. Jam for all mixes were cooked until the final product contained 65% soluble solids (determined by refractometer).

Moisture, protein, lipids and ash were determined according to **AOAC (2000)** where carbohydrate was calculated by difference

Mineral content of all mixed jams was determined according to **AOAC (2005)** using Automatic Absorption Spectrophotometer (Perkin – Elmer, Model 3300, USA)

Assay of total phenolics:

Total phenolic compounds of tested samples were determined by the method of **Slinkard and Singleton (1997)** including Folin- Ciocalteu reagent and gallic acid as standard the extracted solution (0.1 ml) containing 1000 mg extract was taken in a volumetric flask, 46 ml distilled water and added of 1ml Folin-Ciocalteu as reagent and shaken of flask thoroughly for 3 min. After that 3 ml of 2% Na_2CO_3solution was added and all this mixture was shaking and allowed to maintain for 2 h with intermittently shaking. Absorbance was estimated at 760 nm. The same procedure was achieved for all gallic acid solutions as standard.

Carotenoids and ascorbic acid were determined according to **AOAC (2000)**

Antioxidant activity:

The DPPH (2, 2-diphenyl-1-picrylhydrazyl) examine was used according to the method described by **Brand-Williams et al. (1995)** and this method was modified by **Thaipong et al (2006).** The solution samples have been prepared by DPPH (24 mg) was dissolved in (100 ml) methanol and after that kept at −20 °C until used. The optimal solution was obtained by blending the prepared solution (10 ml) with methanol (45 ml) to give an absorbance of 1.1 ± 0.02 units at517 nm by using the Jenway spectrophotometer. The fruit extracts (150 µl) were permitted to achieve the reaction with the DPPH solution (2,850 µl) for one hour in the dark place. After that the absorbance was determined at 517 nm. The antioxidant activity was calculated as a decrease in the absorbance value using the following formula:

$$\text{Inhibition activity (\%)} = (A_0 - A_1/A_0) \times 100\%$$

A_0: control DPPH without samples

A_1: DPPH with samples

Phenolic compounds:

Extraction, separation, and quantification of phenolic compounds were determined according to the method described by **Goupy et al (1999)**. Model HPLC Agilent 1200 series equipped with auto

sampling injector; solvent degasser ultraviolet (UV) detector set 280nm. The column temperature was maintained at 35°C.

Sensory evaluation:

The sensory evaluations of mixed jams were carried out with three replications by 10 trained panelists who were members of the Division of the Horticultural Processing Department of Food Technology Research Institute, Agriculture Research Center. The attributes of mixed jams were organized into flavor (odor and taste), texture, and color and over all acceptability. All organized attributes were scored between 0 (the worst) and 10 (the best quality).

Statistical analysis:

All data were calculated as means and analyzed by SPSS Windows (ver.10.).

RESULTS AND DISCUSSION

Results in Table (1) showed that the moisture content ranged between 32.76±2.06 to 35.18±0.36% in the test of mixes of jam. Mix (2) of jam (containing 50% date, 25%acerola, 25% tomato)had the highest content of moisture (35.18±0.36%), while mix (3) containing (50% apricot, 25%acerola, 25% tomato)recorded the lowest one. Generally, the moisture content of foods can be used as an indicator of its shelf life **(Fellows, 2000),** results are in agreement with **(Ashaye and Adeleke, 2009),** they found that moisture content ranged from 33% to 34% in roselle jam. As protein content of tested mixes jam showed that, mix (3) contained apricot had the lowest content of protein followed by mix (4) while mix (2) and mix (1) had the highest content, respectively. On the other hand, mix jam (4) had the lowest content of fat, meanwhile, mixed jam (1) recorded the highest level of fat. Consequently, the total carbohydrate of all tested mixed jams ranged between 63.13±1.04 (mix 2) to 66.41±3.41% (mix 3). However, the ash content of the tested mixes of jams ranged from 0.25g/100 g to 0.74 g/100 g for mix (4) and mix (2), respectively.

Table (1) Chemical composition of mixing jam fortified with iron (gm /100gm) as basis

Mixed jams	Moisture	Protein	Fat	Ash	Carbohydrate
Mix 1	34.08±1.12	0.68±0.06	0.43±0.17	0.34±0.08	64.47±2.18
Mix 2	35.18±0.36	0.74±0.12	0.21±0.13	0.74±0.12	63.13±1.04
Mix 3	32.76±2.06	0.29±0.10	0.12±0.05	0.42±0.07	66.41±3.41
Mix 4	33.52±0.52	0.35±0.04	0.08±0.02	0.25±0.02	65.80±1.86

Results are presented as mean value of replicates Mean values ±Std. Deviation

Ascorbic acid, total carotenoids, total phenolics and antioxidant activity of all tested mixed jams which were determined directly after processing are shown in Table 2. It could be noticed that, mix jam contain 50% strawberry had the highest amount of total phenolics (640.32 mg GAE/100 g) followed by mixed jam contained 50%date (587.21 mg GAE/100 g) and mix (3) contained 50% apricot which was 354.15 mg GAE/100 g, while mix fig jam had the lowest content of total phenolics (281.03 mg GAE/100 g). Ascorbic acid contents were 92.18 and 126.52 mg /100 g for mixed strawberry and fig mixed jams, respectively. Results also indicated that, mixes jam contained fig, acerola, and tomato (mix 1) had the highest content of ascorbic acid followed by mix (3) then mix (4) and mix (2), respectively. Concerning carotenoids, it could be also noticed that the mixes jam contained 50% apricot recorded (71.18 mg /100 g) while the mix jam contained 50% fig had the lowest content (48.37 mg /100 g). The results of antioxidant activity of mixes jam contained strawberry had the highest inhibition percent (78.30 %) followed by mixed jams contained date (71.48%), meanwhile, antioxidant of mixes contain apricot and jam contain fig were 59.94 and 50.62%, respectively. These results agree by those reported by **Kim and Padilla-Zakour, (2004)** who observed that the decrease in total phenolics (73%), antioxidant capacity (65%). The decrease of total phenolics during jam cooking was reported by **Patras et al. (2011)**, who revealed that the decrement might be as a result of cell disruption structure during processing of fruit and the increased related to nonenzymatic oxidation. The results of antioxidant activity agreed with **Wicklund et al. (2005)**. The temperature was the most significant factor that caused the reduction of antioxidant activity.

Table (2) phytochemical compounds and total antioxidant activities for mix jams enriched with iron (mg /100gm on dry weight basis)

Mixed jams	Ascorbic acids mg/100gm	Total carotenoids mg/100gm	Total phenolics mg GAE/100gm	DPPH inhibition (%)
Mix 1	126.52±1.20	48.37±3.17	281.03±2.11	50.62±1.31
Mix 2	83.07±1,54	60.04±2.36	587.21±4.03	71.48±1.04
Mix 3	104.64±2.88	71.18±0.84	354.15±1.36	59.94±2.22
Mix 4	92.18±3.10	50.74±1.22	640.32±3.82	78.30±2,58

Results are presented as mean value of replicates Mean values ±Std. Deviation

Chemical composition of dried spirulina algae is presented in Table (3). The percentage of moisture content was 8.02%. On the other side, the nutritional composition of dried spirulina has a high level of protein (61.48%). Where, the total carbohydrate, total lipid and ash content were 19.09, 4.63 and 6.78%, respectively. Total carotenoids were 469.13 mg /100gm. Also, minerals content of dried spirulina was determined. Spirulina algae had a high content of iron (34.07 mg /100gm), the content of potassium and sodium were 1862.42 and 1204.58 mg /100gm, magnesium and calcium contents were 268.18 and 185.12 mg /100gm, while zinc was 2.18mg /100gm as basis. **Li et al**

(2006) referenced that the content of protein spirulina ranged from 60 to 70% on dry weight basis, while the plants considered as good protein sources contain only about 35%. Also **Kapoor and Mehta (1993)** found that spirulina is also considered as a good source of the content of total carotenoids which containing ranged about 700-1700 mg /kg, and its considered as the second most important source of pigments compared to other algae. They considered has important role as lipophilic antioxidants cancer prevention agents. However, the inorganic nutrients of most pertinence in Spirulina are calcium and iron. Populaces that devour minimal animal foods as their very own preferences, beliefs, or accessibility are at a higher risk of creating iron insufficiency; moreover, those same people prefer consume a lot of fiber which contains phytates and oxalates which decrement the iron bioavailability in vegetable sources. Also, plant foods contain just non-heme iron, which is increasingly inclined to be influenced by absorption inhibitors **(Koury and Ponka, 2004; Denic and Agrawal, 2007).** Spirulina could be able to counteract these two aspects: a) its iron content is generously high: relatively, cereals which were considered as a good sources of iron ranged from 150 to 250 mg/kg; while blue-green algae contains about 580 to1800 mg/kg; b) algae doesn't have pericardium (as do of cereals), hence forth doesn't present phytates/oxalates that could chelate iron and lower its absorption **(Walter 1997 and World Health Organization 2007).**

Table (3) Proximate chemical composition of dried spirulina algae (as basis)

Chemical Constituents		(DWB)
%	Moisture	8.02±0.81
	Protein	61.48±2.14
	Total carbohydrate	19.09±1.15
	Total lipids	4.63±0.56
	Ash	6.78±0.40
mg/100gm	Total carotenoids	469.13±3.66
	Potassium	1862.42±5.82
	Magnesium	268.18±3.92
	Calcium	185.12±3.11
	Sodium	1204.58±4.65
	Iron	34.07±1.08
	Zinc	2.18±0.08

Results are presented as mean value of replicates Mean values ±Std. Deviation

Phenolic compounds were identified as seen in Table (4) in four mixed jams containing acerola and tomato as a rich source of powerful antioxidants. Results indicated that antioxidant activity is proportional correlation with the total content of polyphenols. Therefore, tested mixed jams containing acerola. Twenty three phenolic compounds were identified by using HPLC: These compounds were Gallic, Proto catechuic, Chlorogenic, Catechin, Epi-Catechin, Caffeine, P-OH Benzoic, Caffeic, Vanillic, Ferulic, Iso-Ferulic, Resveratrol, Ellagic, E-Vanillic, Alpha- Coumaric, Benzoic,3,4,5,Methoxy, cinnamon, Coumarin, Salicylic and Cinnamic. These compounds are interesting due to their health benefits. Chlorogenic acid, 3,4,5, Methoxy, Gallic and Ellagic are of the principal components in mix jam contained 50% fig which were 100.080, 89.876, 75.015 and 53.490 µg/gm, respectively. While the

lowest phenolic compounds content was pyrogallol 0.479 and 4-amino benzoic acid 0.168 µg/gm. However, the mixed jam which contained 50% date had the highest content of chlorogenic, epi-catechin, E-Vanillic and Gallic which recorded 172.60, 154.89, 145.926 and 90.912µg/gm, respectively, while the lowest content of phenolic compounds were Cinnamic, Resveratrol, Ferulic and Coumarin which recorded 18.171, 14.539, 12.689 and 12.590µg/gm, respectively. On the other hand, the jam blend contained 50% apricot had the highest content of Chlorogenic and 3 Hydroxy Tyrosyl compared to other phenolic compounds which were 102.325 and 88.960µg/gm. Moderate content of Gallic, Ellagic, Pyrogallol and E-vanillic was observed (65.693, 54.542, 52.984 and 52.088 µg/gm), respectively. The lowest content of phenolic compounds in mix jams contained 50% apricot was Vanillic and Alpha-coumaric which recorded 6.164 and 4.352µg/gm. Meanwhile, mix jams contained 50% strawberry had the highest phenolic compounds of Caffeine and Benzoic (272.365 and 167.174µg/gm), while the lowest compounds of phenolic was catechin and Cinammic (0.197 and 0.105µg/gm.

Table (4) Identification and quantification of phenolic compounds indifferent mixed jams (µg/gm)

Phenolic compounds	Mixed Jam (1)		Mixed Jam (2)		Mixed Jam (3)		Mixed Jam (4)	
	Rt (min)	µg/gm	Rt (min)	µg/gm	Rt (min)	µg/gm	Rt (min)	µg/gm
Gallic	8.020	75.015	6.960	90.912	8.033	65.693	8.033	78.086
Pyrogallol	8.167	0.479	8.120	70.450	8.147	52.984	8.180	47.552
4-amino benzoic acid	9.002	0.168	9.026	36.006	8.981	27.166	9.011	25.058
3-Hydroxy-Tyrosol	9.052	39.138	9.110	65.503	9.070	88.960	9.133	61.563
Protocatechuic	9.299	11.040	9.271	53.202	-	-	-	-
Chlorogenic	9.741	100.08	9.740	172.60	9.724	102.325	9.747	57.4
Catechin	10.181	22.234	-	-	-	-	10.221	0.197
Epi-Catechin	-	-	10.213	154.89	-	-	-	-
Caffeine	10.568	24.804	10.520	60.089	10.568	16.256	10.539	272.367
P-OH-Benzoic	10.696	16.541	10.701	58.619	10.686	56.362	10.729	12.042
Caffeic	10.804	14.884	10.842	16.289	-	-	10.809	9.915
Vanillic	10.903	4.981	10.928	16.028	10.969	6.164	10.908	7.412
Ferulic	12.273	7.210	12.253	12.689	12.274	13.306	-	-
Iso-Ferulic	12.547	24.882	12.515	55.664	12.501	19.504	-	-
Resveratrol	-	-	12.851	14.539	12.781	13.720	12.858	4.871
Ellagic	13.147	53.490	-	-	13.180	54.542	13.173	52.411
E-Vanillic	-	-	13.371	145.926	13.399	52.088	-	-
Alpha-Coumaric	-	-	13.579	51.998	13.548	4.352	13.495	5.026
Benzoic	-	-	13.844	70.399	-	-	13.867	167.174
3,4,5,Methoxy cinnamon	14.013	89.876	14.004	25.109	-	-	14.045	42.051
Coumarin	-	-	14.187	12.590	14.234	16.743	-	-
Salicylic	14.553	24.176	-	-	-	-	14.580	22.496
Cinammic	15.093	2.734	15.136	18.171	-	-	15.123	0.105

Results are presented as mean value of replicates Mean values ±Std. Deviation

Minerals content of mixed jams enriched with iron are shown in (Table 5). Results indicate that, mix jam which contained strawberry had the highest magnesium content (34.95mg /100gm) followed by mix jam contained fig (25.91mg /100gm)and mix jam contained date (11.37 mg /100gm), while mix jam contained apricot had the lowest magnesium content (3.55 mg /100gm). Subsequently,

Sodium content ranged from 86.74 to124.12 mg/100gm for date and apricot mixed jams, respectively. Mix jams contained date had the highest content of potassium (95.69 mg /100gm) and calcium (22.77 mg /100gm) while, the lowest content was 71.48 mg/100 gm of potassium and 14.05 mg/100 gm of calcium for mixed jams contained fig and apricot. Generally, all tested mix jams were high content of iron because of enrichment with 5 gm/100gmspirulina algae and 1.33 mg/100gm ferrous gluconate). Therefore, mix jam contained date had the highest content of iron (6.21mg /100gm) followed by mix jam contained strawberry (5.91 mg /100gm), jam contained fig (5.85mg /100gm) and mix jam of apricot (5.67mg /100gm), respectively. Zinc content was lies in between (0.27 to 0.48mg /100gm), strawberry mix jam recorded 0.48mg /100gm while, mix jam contained fig recorded 0.27 /100gm the highest and the lowest zinc content, respectively. **Gakowska et al. (2010)** reported that the higher Ca content was 27.26– 55.44 mg/100 g in the samples of strawberry jams. Also, the content of ferrous in grape and apricot jams will in general have comparable levels of iron. While, ferrous levels in both blueberry and strawberry jams tend to higher than other samples. The level of ferrous in the examined jams was similar to that revealed in fresh fruits.

Table (5) Minerals content of mix jams enriched with iron mg /100gm

Mixed jams	Mg	Na	K	Ca	Fe	Zn
Mix 1	25.91	90.61	71.48	15.48	5.85	0.27
Mix 2	11.37	86.74	95.69	22.77	6.21	0.45
Mix 3	3.55	124.12	83.60	14.05	5.67	0.34
Mix 4	34.95	116.15	72.18	19.52	5.91	0.48

Results are presented as mean value of replicates Mean values ±Std. Deviation

Organoleptic evaluation shown in Table (6) was the average decision for color, taste, odor and texture of tested mix jams expressed by ten qualified panelists. The color was scored from 7.33 to 8.42. It could be seemed that mix 4 (containing 50% strawberry) had the highest score for color while mix 2 (containing 50% date) was the lowest one. As for taste, the mix jams contained date recorded the lowest score of color comparing with other tested mix jam. The average score of taste ranged from 7.38 for date mix jam to 8.32 for strawberry mix jam. Also, odor recorded the highest score with mix strawberry jam (8.08) while mix date jam which recorded the lowest score (7.00). Therefore, mix jam contained strawberry (mix 4) recorded the best score overall acceptability followed by mix jam (3), mix jam (2) and mix jam (1), respectively.

Table (6) Sensory evaluation of mix jams enriched with iron

Mixed jams	Color	Taste	Odor	Texture	Overall acceptability
Mix 1	7.58±1.02	7.66±0.62	7.83±0.28	7.75±0.73	7.58±0.17
Mix 2	7.33±0.83	7.38±0.18	7.00±0.66	7.17±0.35	7.75±1.06
Mix 3	8.00±0.16	7.50±1.11	7.58±1.07	8.16±0.94	8.00±0.61
Mix 4	8.42±0.34	8.32±0.48	8.08±0.13	7.92±0.68	8.08±0.24

Results are presented as mean value of replicates Mean values ±Std. Deviation

REFERENCES

AOAC (2000). Official Methods of Analysis of AOAC International 17th Ed. Association of Analytical Chemists, Gaithersburg, Maryland, DC, USA.

AOAC (2005). Official Methods of Analysis of AOAC International 18th Ed. Association of Analytical Chemists, Washington, DC, USA.

Ashaye, O.A. and T.O. Adeleke (2009). Quality attributes of stored Roselle jam. Int. Food Res. J., 16: 363–371.

Barkallah, M.; M. Dammak; I. Louati; F. Hentati and B. Hadrich (2017). Effect of Spirulina platensis fortification on physicochemical, textural, antioxidant and sensory properties of yogurt during fermentation and storage. LWT - Food Science and Technology, 84: 323-330.

Berger, J. (2003). Fortification of foods with micronutrients: a component of an integrated strategy to control micronutrient deficiencies, especially iron deficiency, in developing countries 2ème Atelier international / 2nd International Workshop Food-based approaches for a healthy nutrition Ouagadougou, 11: 23-28.

Brand-Williams, W.; M. E. Cuvelier and C. Berset (1995). Use of free radical method to evaluate antioxidant activity. Lebensmittel- Wissenschaft und Technologie, 28: 25 – 30.

Catană, M.; L. Catană; M. Negoiţă; E. Iorga; N. Belc; G. Lilios; V. Chiţu and A. Popp Stănescu, (2013). Fruit-based concentrated products, iron fortified, destined to prevention and died therapy of iron deficiencies. International Socity for Horticultural Science. 981: 729-733.

Denic, S. and M.M. Agarwal (2007). Nutritional iron deficiency: an evolutionary perspective. Nutr; 23: 603-14.

Fellows, P.J. (2000). Food Processing Technology, Principles and Practice. CRC Press, Boca Raton Boston New York Washington, DC, WoodHead Publishing Limited, Cambridge, England.

Gakowska, D.; T. Fortuna and W.P. Zago´rska (2010). Physicochemical quality of selected strawberry jams with fructose. Potravinarstvo, 4(2): 22-24.

Goupy, P.; M. Hugues; P. Boivin and M.J. Amoit (1999). Antioxidant composition and activity of barley (Hordeumvulgare) and malt extracts and of isolated phenolic compounds. J. Sci. Food Agric., 79: 1625-1634.

Gutiérrez-Salmeán, G.; L. Fabila-Castillo and G. Chamorro-Cevallos (2015). Nutritional and toxicological aspects of Spirulina (Arthrospira). Nutr Hosp.; 32 (1):34-40.

Horta, R. N.; V.F.S. Kahl, M. S. Sarmento; M.F.S. Nunes; C.R.M. Porto; V.M. Andrade; A. B. F. Ferraz and J. D. Silva (2016). Protective effects of acerola juice on genotoxicity induced by iron in vivo.Genet Mol Biol. 39 (1):122-129.

Kapoor R. and U. Mehta (1993). Utilization of beta-carotene from Spirulina platensis by rats. Plants Foods Hum Nutr, 43 (1): 1-7.

Kim, D.O. and O.I. Pailla-Zakour (2004). Jam processing effect on total phenolics and antioxidant activity capacity in anthocyanin-rich fruits: Cherry, plum, and raspberry, sensory and nutritive qualities of food. J. Food Sci. 69:395–400

Koury, M. J. and P. Ponka (2004). New insights into erythropoiesis: the roles of folate, vitamin B12 and iron. Annu Rev Nutr. 24: 105-136.

Li, Z.Y.; S.Y. Guo; L. Li and M.Y. Cai (2006). Effects of electromagnetic field on the batch cultivation of Spirulina platensis in an air-lift photobioreactor. Bioresour Technol. 98, 3:700-5.

Mogos, V.T. (1997). Alimentaţia în bolile de nutriţieşi metabolism, Editura Didactică şi Pedagogică, R.A. Bucureşti. 391: 409- 422.

Neher, B. D.; S. M. Azcarate; J. M. Camiña and M. Savio (2018). Nutritional analysis of Spirulina dietary supplements: Optimization procedure of ultrasound-assisted digestion for multi element a determination Food Chemistry, 257, 15: 295-301.

Patras, A.; N.P. Brunton, B.K. Tiwari, and F. Butler (2011). Stability and degradation kinetics of bioactive compounds and color in strawberry jam during storage. Food Bioprocess Technol. 4:1245-1252.

Slinkard, K. and V.L. Singleton, (1997). Total phenol analyses: automation and comparison with manual methods. Am. J. Enol. Viticult. 28: 49–55.

Thaipong, K.; U. Boonprakob; K. Crosby; L. Cisneros-Zevallos and D.H. Byrne (2006). Comparison of ABTS, DPPH, FRAP, and ORAC assays for estimating antioxidant activity from guava fruit extracts. J. Food Composite Anal 19: 669-675.

Walter, P. (1997). Effects of vegetarian diets on aging and longevity. Nutr Reviews; 55(1): S61- S68.

Wicklund, T.; H. J. Rosenfeld; B. k. Martinsen; M.W. Sundfor; P. Lea; T. Bruun; R. Blomhoff and K. Haffner (2005). Antioxidant capacity and colour of strawberry jam as influenced by cultivar and storage conditions. LWT- Food Science and Technology. 38, 387-391.

World Health Organization (2007). Centers for Disease Control and Prevention. Assessing the iron status of populations: including literature reviews: report of a Joint World Health Organization/Centers for Disease Control and Prevention Technical Consultation on the Assessment of Iron Status at the Population Level, Geneva, Switzerland, 6-8 April 2004, 2nd ed.

الملخص العربي

تصنيع بعض خلطات المربي المرتفعة في محتواها بمضادات الأكسدة والمدعمة بالحديد

جورج عبيد عبد الملاك – محمد الأمين محمد موسي – منال عباس الجندى

استهدفت الدراسة تحضير مربي من خلطات لبعض الفاكهة والخضر لاثرائها بمضادات الأكسدة والحديد حيث أضيفت الأسيرولا والطماطم لمحتواهما المرتفع من مضادات الأكسدة وكذلك تدعيم خلطة المربي ب 5 جم/100جم من طحلب الاسبيرولينا الغني بعنصر الحديد مع اضافة 3 جم /100 جلوكونات الحديدوز لكل خلطة من خلطات المربي التي تم تحضيرها

أظهرت النتائج أن خلطات المربي التي تم تحضيرها تحتوى على الكربوهيدرات بنسبة تتراوح بين 63.13: 66.41 جم/100جم لخلطات المربي المحتوية علي 50 % من التمر والمشمش علي التوالي . هذا وقد تراوح المحتوي من الرماد بين 0.25: 0.74 جم/100جم لكل من خليط مربي الفراولة والتمر على التوالى. ومن ناحية اخري فلقد كان محتوي خلطة المربي المحتوية علي 50% فراولة من الفينولات الكلية 640.32 مجم/100جم بينما كان خلطة المربي المحتوية علي 50% تين ذات محتوي الأقل من الفينولات الكلية (281.03 ملجم/100جم).

هذا ولقد اوضحت الدراسة ان محتوي حمض الاسكوربيك تراوح بين 83.07 الي 126.52 مجم/100جم. بينما لوحظ ان اعلي محتوي من الكاروتينات الكلية كان في خلطة المربي المحتوية علي 50% مشمش (71.18 ملجم/100جم) وان خلطة المربي المحتوية علي 50% تين كان محتواها منخفض من الكاروتينات الكلية (48.73 ملجم 100جم) وايضا احتوت على أقل كمية من حامض الاسكوربيك (48.73ملجم/100جم). اوضحت الدراسة بالنسبة لنشاط مضادات الأكسدة المختلفة ان أعلى نسبة نشاط كانت مع خليط مربي الفراولة حيث كانت 78.3%. ولقد بينت الدراسة ان طحلب الاسبيرولينا كان محتواه من البروتين 61.48% كما سجل كل من الكربوهيدرات والليبدات والرماد 19.09، 4.63، 6.78 % على التوالى على أساس الوزن الجاف وكان محتواه من الكاروتينات 469.13 ملجم/100جم بينما كان محتوي الحديد 34.07 مليجرام/100جم

هذا ولقد امكن التعرف علي 23 مركب من المركبات الفينولية منها بروتوكتشوك، كلوروجينيك ، كاتشين ومركبات أخرى تم التعرف عليها تلك المركبات هامة من الناحية الصحية.

هذا ولقد لوحظ ان خلطات المربي التي تم اعدادها كانت ذات محتوي مرتفع من عنصر الحديد نتيجة لإضافة طحلب الاسبيرولينا والتدعيم بجلوكونات الحديدوز مع ملاحظة ان خليط المربي المحتوية علي 50% تمر احتوت علي 6.21 ملجم/100جم حديد بينما خلطة المربي المحتوية علي 50% مشمش كان محتواها الأقل من عنصر الحديد مقارنة بخلطات المربي الاخري.