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PRODUCTION OF INSTANT ORANGE JUICE POWDER BY FOAM-MAT DRYING

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ABSTRACT

This study aims to introduce an instant baladi orange juice powder, which could be industrially processed and consumed allover the year as the production of this fruit is very huge. In this study powder was prepared by the foam mat drying method. The obtained results revealed that total soluble solids (T.S.S.) content of fresh Baladi orange juice was about 12% including 10.2% total sugars, 1.11% total acidity and about 55 mg/100 gm ascorbic acid. The reducing sugars content represented about 51.07% of the total sugars. It was also concluded that through this investigation the fresh orange juice concentrated by rotary evaporator (at 40°C and 28 Hg) to 20% T.S.S. resembled the fresh Baladi orange juice. The obtained data also revealed that 0.8 to 1.5% of added albumin was the best concentration for foaming. It was proved that adding 0.5% carboxy methyl cellulose was very suitable for improving the foaming state. Concerning the organoleptic evaluation, it could be noticed that the juice concentrated by rotary evaporator was better as compared to that concentrated by the same method after adding sucrose.

Key words: Foam – Powder – Drying – Juice – Orange.

INTRODUCTION

orange fruits (*Citrus sinensis*) are one of the most popular fruits in Egypt, cultivated successfully in Kalioubia, Alexandria, Helwan, Domieta, Assuit and Sharkia in addition to some other Governorates. The total production of orange fruits in Egypt was about 1441652 tons representing more that 50% of citrus production. However, the total area of oranges reached about 209007 feddans in 1997 (Anonymous, 1999). Orange fruits especially the Baladi variety are considered of excellent organoleptic qualities, due to the high content of organic acids, and some other nutrients as well as the pronounced delicate flavoring material. In the A.R.E. these fruits are usually consumed fresh while a limited quantities are directed to processing.

An interesting perhaps quite significant innovation in the dehydration of fruit and vegetable juices using foam-mat drying technique were reported by Karim and Wai (1999) and Attia (2000). Foam-mat drying has two definite advantages i.e. the use of foams greatly speeds moisture removal and permits drying at the atmospheric conditions in a stream of hot air in a short time. The other advantage is that even though the product may be sticky at the drying temperature, it could be transferred to a cooling zone and crisped before it is seraped off at the surface, Berry *et al.* (1972).

Monostearate, solubilized soya protein, albumin and sucrose fatty acid esters have been used as foaming agents in experimental operations. For most products one percent foaming agent on dry basis is adequate. This

technique has been successfully employed on a small scale in drying a wide variety of products including orange, tomato, pineapple juices, mashed potatoes, baby foods, whole milk, coffee, apricot and prune purees and apple sauce (Karabulya and Lieberman, 1983; Askar *et al.*, 1992 and Siliha *et al.*, 1994).

The aim of this study includes the possibility of utilization of the Baladi orange juice in the production of dried orange product, which could easily be preserved for a long time and consumed locally and/or oriented to exportation.

MATERIALS AND METHODS

A) Materials:

Mature Baladi orange fruits (*Citrus sinensis*) used in this study were obtained from a private orchard, Kalioubia Governorate.

Albumin powder and carboxy methyl cellulose (CMC) were purchased from Alkan Company. Commercial local sucrose was used in the study.

B) Methods:

Preparation of orange fruit juice powder:

Preparation of Fresh Juice:

Baladi orange fruits were sorted, washed with running water then cut into haves. The juice was extracted and manual pressed (reamer type) then strained. The extracted juice was divided into the following treatments:

The first treatment represented the fresh juice containing 12% total soluble solids (control). In the second treatments, albumin was added to the fresh orange juice in the concentration of 0.8%. The third treatment was similar to the second but differed in raising the total soluble solids to 16% by adding sucrose. The fourth treatment represents fresh orange juice with 1% albumin only (T.S.S/ 13.5%). The fifth treatment was similar to the fourth but differed in raising the concentration to 16% (T.S.S.) by adding sucrose. The sixth to thirteenth treatments were prepared as the above mentioned ones but with adding carboxy methyl cellulose (CMC) in a concentration of 0.5% and/or 1%.

Preparation of Concentrated Juices:

The extracted juice was divided into five parts and treated as follows:

1- The first part of the juice was concentrated by rotary evaporator at 40°C at 28 Hg to 20%.
2- The second part of orange juice was similar to the first (16% T.S.S.) then sugar was added up to the final concentration of 20% T.S.S.
3- The third part was similar to the first one but differed in that the concentration reached 30% T.S.S.
4- The fourth part was similar to the second part (up to T.S.S. 26%) then sugar was added to the concentration of 30% T.S.S.
5- The last part was similar to the first but total soluble solids of the juice reached 40% after concentration.

A quantity of 1.5% albumin powder was added to all the aforementioned concentrated juice treatments.

Foaming Process:

Orange juice was blended with different ratios being 0.8%, 1% and 1.5% dried egg albumin solely as foaming agent and then whipped in Hobart mixer for 5 min. to increase the volume about three folds. All the aforementioned treatments were separately poured into stainless steel trays coated with paraffin oil to prevent sticking. A laboratory drying oven was used at 60°C (Garcia *et al.*, 1988). The dehydrated powder (3% moisture content) of each treatment was reconstituted in water and T.S.S. was adjusted to 14%. The organoleptic evaluation was accomplished by ten panelists.

Methods of Analysis:

Moisture, ash total sugars, reducing and non-reducing sugars, specific gravity and total acidity contents were determined according to methods described in the A.O.A.C. (1990). Total soluble solids (T.S.S.) and refractive index were determined using a Carl Zeiss refractometer. Besides, color index was measured as optical density at 420 nm using Shimadzu LN 120-02 spectrophotometer (Moore *et al.*, 1942). The pH value was determined directly using a Beckman glass electrode pH meter. Ascorbic acid content was determined using 2, 6 dichloro phenol indophenol (Pearson 1984). Calcium and potassium were determined after ashing using a Pye Unican absorption spectrophotometer (Rowe, 1973). Viscosity was estimated using Brookfield viscometer using Spindle No. 3 at different speeds.

Organoleptic Evaluation and Statistical Analysis:

The dehydrated powder of each aforementioned treatment was reconstituted by water and the total soluble solids (T.S.S.) was adjusted to 14%. All samples were evaluated by ten panelists and their average decisions were recorded. A scale from 1 to 10 was applied to evaluate color, taste and texture (Notter *et al.*, 1959). The obtained data were statistically analyzed according to the method of Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

1- Chemical and Physical Properties of Fresh Orange Fruits:

The data given in Table (1) indicates the results of the chemical constituents and physical properties of Baladi orange juice (fresh weight basis). Total soluble solids, pH value and refractive index were 12, 3.6 and 1.0518 respectively. Moisture content and total acidity (calculated as citric acid) were 88% and 1.11%. Total sugars were 10.2% while ascorbic acid content was 55mg/100 g. The same table reveals that calcium was 39mg/100 g and potassium was 236 mg/100 g. These results are in agreement with those reported by Morgan *et al.* (1961), Fahmi (1967), Berry et al. (1972) and El-Hamzy (1996).

Table (1): Chemical and Physical properties of Baladi orange fruits (Calculated as fresh weight basis).

Constituents		Content
Moisture content	(%)	88
Total soluble solids (T.S.S.)	(%)	12
pH value		3.6
Specific gravity		1.0518
Refractive index		1.3530
Color index (as optical density at 420 nm)		0.08
Viscosity (centipoises)		1400
Total titratable acidity	(%)	1.11
Reducing sugars	(%)	5.21
Non reducing sugars	(%)	4.99
Total sugars	(%)	10.2
Ascorbic acid	(mg/100 g)	55
Ash	(%)	0.4
Calcium	(mg/100 g)	39
Potassium	(mg/100 g)	236

2- Effect of Added Albumin and Sucrose on Physical and Chemical Properties of fresh Baladi orange juice :

From Table (2), it could be observed that total soluble solids (T.S.S.) varied between 12 to 16% in all treatments. It is evident that an inversely proportional correlation existed between total acidity and pH value. From the same table, it could be noticed that viscosity readings in concentrated juice (T.S.S. 16%) were slightly higher than those of fresh juices (T.S.S. 13%). It would be known that a direct proportional correlation existed between the viscosity and specific gravity in the aforementioned treatments. It could be also noticed that the color index decreased in all treatments compared to the control. These results coincide with Cooke *et al.* (1976) and Masoud (1998).

Table (2):Effect of added albumin and sucrose on physical and chemical properties of fresh Baladi orange juice.

Physical and chemical properties	* Treatments				
	No. 1	No. 2	No. 3	No. 4	No. 5
T.S.S. (%)	12	13	16	13.5	16
pH value	3.6	3.65	3.7	3.74	3.8
Specific gravity	1.0518	1.0536	1.0693	1.0669	1.0699
Refractive index	1.3530	1.3532	1.3580	1.3540	1.3590
Color index	0.08	0.056	0.052	0.054	0.051
Viscosity (centipoises)	1400	1410	1416	1412	1420
Reducing sugars (%)	5.21	5.32	6.68	5.50	7.01
Non reducing sugars (%)	4.99	5.23	6.75	5.5	6.99
Total sugars (%)	10.20	10.55	13.50	11.00	14.00
Ascorbic acid (mg/100 g)	55	39.4	42.9	42.8	44.2
Total acidity (%)	1.11	1.18	1.02	0.92	0.85

*** Treatments;**

No. 1: Fresh Baladi orange juice (control).

No. 2: Fresh Baladi orange juice after adding 0.8% albumin.

No. 3: Fresh Baladi orange juice after adding 0.8% albumin then raising the concentration up to 16% T.S.S. by adding sucrose.

No. 4: Fresh Baladi orange juice after adding 1% albumin.

No. 5: Fresh orange juice after adding 1% albumin and raising the concentration up to 16% T.S.S. by adding sucrose.

Effect of added albumin and sucrose on physical and chemical properties of concentrated orange juice:

Single strength Baladi orange juice with total soluble solids (T.S.S.) 12% was concentrated into 30% by rotary evaporator and/or the T.S.S. content in the fresh juice was raised to approximately 40% by the addition of sucrose. From Table (3), it could be noticed that total titratable acidity, reducing sugars and total sugars contents increased as affected either by concentration in the rotary evaporator or by adding sucrose. Meanwhile, pH value and specific gravity decreased in all the aforementioned treatments. As for color expressed as color index, no pronounced increase was observed.

Table (3):Effect of added albumin and sugar on physical and chemical properties of concentrated orange juice.

Physical and chemical properties	* Treatments				
	No. 1	No. 2	No. 3	No. 4	No. 5
T.S.S. (%)	20	20	30	30	40
pH value	3.42	3.4	3.41	3.40	3.40
Specific gravity	1.1290	1.1291	1.158	1.1583	1.1614
Refractive index	1.3820	1.3822	1.3430	1.3432	1.3440
Color index	0.4	0.42	0.81	0.85	0.72
Viscosity (centipoises)	4000	4200	6000	6330	8000
Reducing sugars (%)	6.54	6.33	11.02	11.53	15.45
Non reducing sugars (%)	6.62	6.79	11.53	11.08	16.17
Total sugars (%)	13.16	13.12	22.55	22.61	31.62
Ascorbic acid (mg/100 g)	22.2	22.1	23.8	23.7	21.3
Total acidity (%)	6.01	6.02	6.5	6.52	7.3

*** Treatments;**
No. 1: Orange juice concentrated by rotary evaporator (T.S.S. 20%).
No. 2: Orange juice concentrated by rotary evaporator and raising the concentration up to 20 T.S.S. by adding sucrose.
No. 3: Orange juice concentrated by rotary evaporator up to 30 T.S.S.
No. 4: Orange juice concentrated by rotary evaporator and raising the concentration up to 30 T.S.S.
No. 5: Orange juice concentrated by rotary evaporator until concentration of 40 T.S.S.

From The same Table, it could be seen that a proportional correlation existed between the viscosity and concentration process either rotary evaporator and/or after adding sugars. Concerning the refractive index, there is no significant differences among all the aforementioned treatments. These results are in agreement with Robert *et al.* (1965), Brygdy *et al.* (1977) and El-Anany (1997).

Within the aforementioned parts of concentration orange juice. It was found that orange juice concentrated by rotary evaporator without adding sugar T.S.S. 50% was very sticky. Therefore, this proportion was discarded. The addition of albumin to the fresh juice by 0.2%, 0.4% and 0.6% caused a lower increment in foam volume compared to the other ones, therefore, these treatments were discarded.

4- Statistical Analysis of Organoleptic Evaluation:

Organoleptic evaluation data of Baladi orange powder obtained by foam-mat drying method was statistically analyzed. Means comparison for parameters color, texture, and taste used to evaluate the orange powder is

shown in Table (4). Results show insignificant differences between treatments 2, 3, 5, 6, 7, 8 and control sample in color, taste and texcture.

As a general conclusion, this study proved that foam-mat drying relates to dehydration of food material by using foaming agent and the final product was low in moisture content, extremely porous and was capable of being rehydrated instantly and rapidly for use.

Table (4): Statistical analysis of orgnoleptic evaluation of instant orange juice powder by foam-mat drying.

No.	Treatments	Color LSD = 0.974	Texture LSD = 0.983	Taste LSD = 1.076
		Mean	Mean	Mean
1	Juice	6.9^{CD}	6.5^{D}	6.1^{EF}
2	Juice + 0.8% albumin	6.5^{DE}	6.9^{CD}	6.0^{F}
3	Juice + 0.8 albumin + sugar	6.8^{CD}	6.7^{CD}	6.7^{CDEF}
4	Juice + 1% albumin	7.2^{BCD}	7.4^{BCD}	7.4^{BCD}
5	Juice + 1% albumin + sugar	7.6^{BC}	6.8^{CD}	6.6^{CDEF}
6	Juice + 0.8% albumin + 0.5% CMC	7.2^{BCD}	6.6^{CD}	7.0^{BCDEF}
7	Juice + 0.8% albumin + 0.5% CMC + sugar	7.6^{BC}	6.5^{D}	6.7^{CDEF}
8	Juice + 1% albumin + 0.5% CMC	7.7^{BC}	7.3^{BCD}	6.8^{CDEF}
9	Juice + 1% albumin + 0.5% CMC + sugar	7.3^{BCD}	7.9^{AB}	6.4^{DEF}
10	Juice + 0.8% albumin + 1% CMC	7.4^{BCD}	7.9^{AB}	6.8^{CDEF}
11	Juice + 0.8% albumin + 1% CMC + sugar	7.6^{BC}	8.1^{AB}	7.4^{BCD}
12	Juice +1% albumin + 1% CMC	7.3^{BCD}	7.5^{BC}	7.4^{BCD}
13	Juice +1% albumin + 1% CMC + sugar	9^{A}	8.7^{A}	8.6^{A}
14	Juice concentrated 20% + 1.5% albumin	8^{B}	8.8^{A}	7.9^{AB}
15	Juice concentrated 20% with sugar + 1.5%albumin	7.7^{BC}	7.5^{BC}	7.1^{BCDE}
16	Juice concentrated 30% + 1.5% albumin	7.2^{BCD}	6.5^{D}	7.5^{BC}
17	Juice concentrated 30% with sugar + 1.5% albumin	5.7^{E}	5.3^{E}	4.5^{G}
18	Juice concentrated 40%	4.7^{F}	2.3^{F}	1.9^{H}

The mean scores in column with the same letter or letters are not significant different at 5%.

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إنتاج مسحوق عصير البرتقال البلدى بالتجفيف بطريقة الرغوة

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أجرى هذا البحث بغرض إنتاج مسحوق عصير البرتقال البلدى الذى يمكن تصنيعه واستهلاكه طوال السنة وذلك لأن إنتاج هذا المحصول فى مصر وفير. وقد تم إعداد هذا المسحوق بطريقة التجفيف بالرغوة. وقد دلت النتائج المتحصل عليها أن تركيز المواد الصلبة الذائبة الكلية فى عصير البرتقال البلدى الطازج كان حوالى 12% متضمناً 10.2% سكريات كلية، 1.11% حموضة كلية وحمض الاسكوربيك بتركيز 55ملليجم/100 جم وتمثل السكريات المختزلة نحو 51.07% من السكريات الكلية، كما ثبت من هذه الدراسة أن عصير البرتقال الطازج والمركز بواسطة جهاز المبخر الدائرى على درجة حرارة 40°م وتفريغ 28بوصة زئبق مماثل لعصير البرتقال البلدى الطازج. كما أثبتت الدراسة أن استخدام الألبيومين بتركيزات 0.8-1.5% مع 0.5% كربوكسى ميثيل سليلوز كانت أفضل لإنتاج وتحسين الرغوة، ووجد أيضاً من التقييم الحسى أن عصير البرتقال الطازج والمركز بواسطة جهاز المبخر الدائرى بعد الإسترجاع كان أكثر أفضلية وقبولاً لدى المحكمين عن الذى رفع تركيزه بالمبخر وبإضافة السكر.