UNTRADITIONAL METHODS OF PROCESSING OF NAVEL ORANGE FRUITS

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Abstract

The present study was undertaken to evaluate the suitability of navel orange fruits for the production of compote and navel orange juice rich in juice sacs. Chemical, physical and sensory characteristics as affected by some technological treatments were evaluated. The effect of calcium chloride, enzymatic treatments, juice sac and storage period were also studied.

The results showed indicate that the utilization of enzyme treatments improved the juice yield, chemical composition and sensory attributes. The juice yield after enzyme treatments approached that of balady orange juice. Navel orange juice blended with the juice sacs was more preferred by the paneltists. Monosaccharides were faster to transfer from the solution into the compote compared to other saccharides, in addition to having a rapid effect on chemical, physical and sensory changes, while Ca++ ions and the storage period had affected tissue firmness and sensory characteristics.

INTRODUCTION

Orange fruits are considered as the most refreshing delioious and wholesome. Their juices are rich in ascorbic acid, sugars, citric acid and minerals *(El-Ashwah et al., 1975),* who mentioned that balady orange at its maturity stage contain total acidity % (as citric acid) 1.72, ascorbic acid (mg/100gm) 56.60 and β-carotene (mg/100gm) 0.194, which contributed to health promoting ingredients of the human diet. Most of oranges cultivated in the A.R.E. are of the Wahington navel variety reaching about 114739 feddans, producing about 1008445 tons according to the statistical report of the Ministry of Agriculture, Egypt, 2003. However the total areae of citrus was 204045 feddans. The Egyptians used to consume navel oranges generally in the fresh state but not as single strength juice extracted therefrom. However an increasing lots of packed fresh oranges are annually exported to different countries.

Application of enzymes is now being practised in the citrus processing industry in order to increase the product yield, soluble solids recovery, lowering juice viscosity, bitterness reduction which may affect the product qualities *(Don Gowshi and Sembries, 2001).*

Non-enzymatic browning of fruit slices during processing and storage is largely due to the end products of the Maillard reaction having an important quality factor for marketing, flavour, color and nutritional qualities. Reaction rates depend on temperature, pH value, water activity, types of sugar such as sucrose, glucose and fructose and other compounds *(Raoult-Wack, 1994)*.

The present study was carried out to produce compote from navel oranges and to improve the yield of juice as well as the production of untraditional navel orange juice rich in juice sacs.

MATERIALS AND METHODS

Materials:

Washington navel oranges (Citrus sinensis, osbock) used in this study were obtained at the first week of Januray from a private orchaid in Sharkia governorate. These trees were 18 years old, budded on sour orange stock (*Citrus Aurantium*, L).
Ultra SPI enzyme (USP), Novo Nardish Switzarland.
Commercial sugars, Sucrose and glucose syrup were obtained from supermarket.

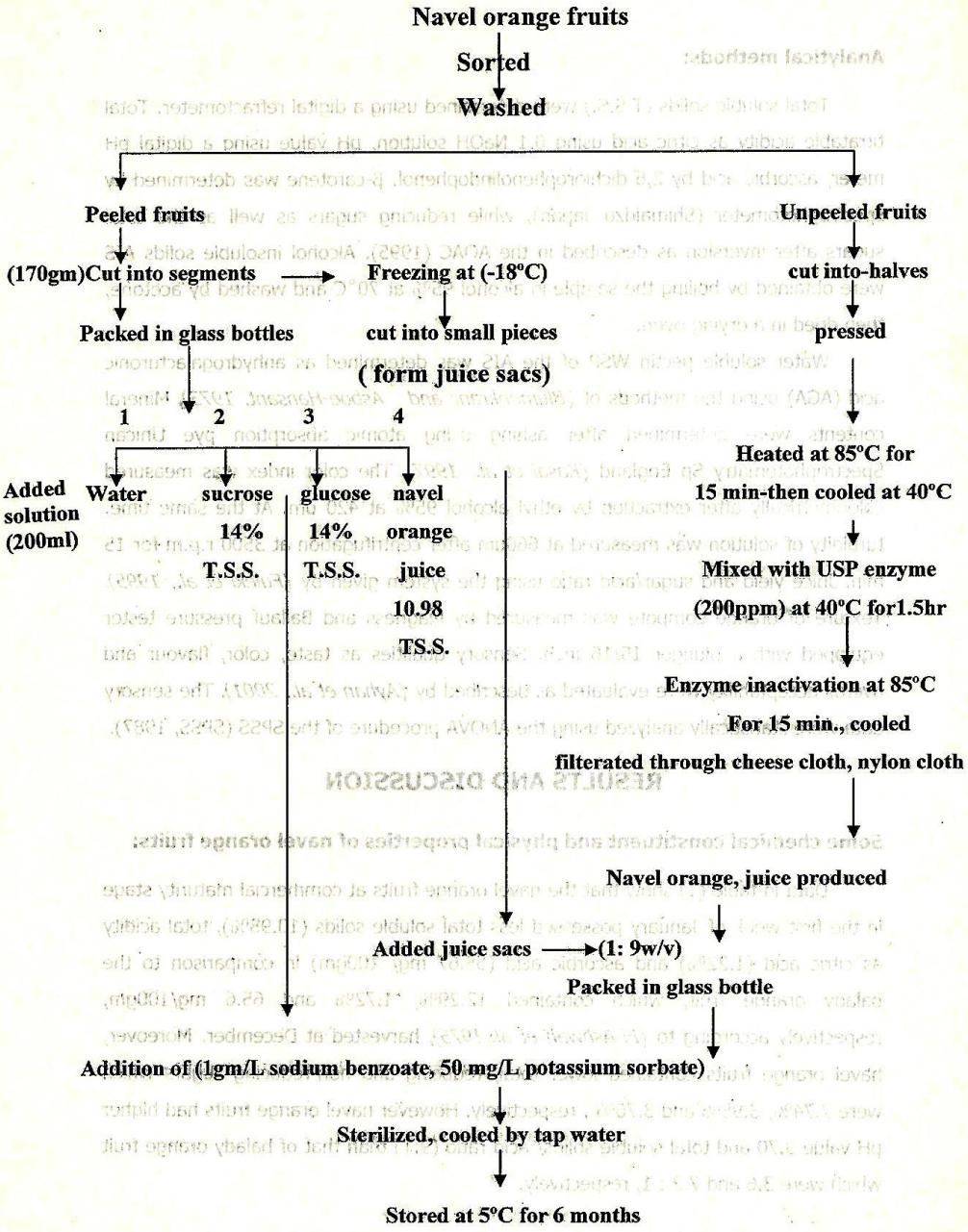
Methods:

1- Preparation of navel orange compote:

Fruits were washed, peeled, cut into segments, then the compote was prepared as described in Fig 1. A solution of $CaCl_2$ at 0.5% was added to the compote samples while another sample was left without treatment as a control.

2- Preparation of navel orange juice rich in juice Sacs:

At the same time the navel oranges were affected by enzyme treatments (USP enzyme) and / or without the addition of enzyme. The juice sacs were added to the juice sample, according to the flow sheet given in Fig. 1.



T.S.S.: Total soluble solids

Fig. 1. Flow sheet showing the preparation of navel orange compote and juice sacs.

Analytical methods:

Total soluble solids (T.S.S.) were determined using a digital refractometer. Total titratable acidity as citric acid using 0.1 NaOH solution, pH value using a digital pH meter, ascorbic acid by 2,6 dichlorophenolindophenol. β-carotene was determined by spectrophotometer (Shimaidzu Japan), while reducing sugars as well as the total sugars after inversion as described in the AOAC (1995). Alcohol insoluble solids AIS were obtained by boiling the sample in alcohol 95% at 70°C and washed by acetone, then dried in a drying oven.

Water soluble pectin WSP of the AIS was determined as anhydrogalacturonic acid (AGA) using the methods of (*Blumenkranz and Asboe-Hansant, 1973).* Mineral contents were determined after ashing using atomic absorption pye Unican Spectrophotomatry Sp England *(Kasai et al., 1997).* The color index was measured colorimetrically after extraction by ethyl alcohol 95% at 420 um. At the same time, turbidity of solution was measured at 660um after centrifugation at 3500 r.p.m for 15 min. Juice yield and sugar/acid ratio using the system given by *(Fuleki et al., 1995).* Texture of orange compote was measured by Magness and Ballauf pressure tester equipped with a plunger 15/16 inch. Sensory qualities as taste, color, flavour and overall acceptability were evaluated as described by *(Ayhan et al., 2001).* The sensory data were statistically analyzed using the ANOVA procedure of the SPSS (SPSS, 1987).

RESULTS AND DISCUSSION

Some chemical constituent and physical properties of navel orange fruits:

Data in table (1) show that the navel orange fruits at commercial maturity stage in the first week of January possessed less total soluble solids (10.98%), total acidity as citric acid (1.22%) and ascorbic acid (55.67 mg/ 100gm) in comparison to the balady orange fruit, which contained 12.29%, 1.72% and 65.6 mg/100gm, respectively according to *(El-Ashwah et al.,1975),* harvested at December. Moreover, navel orange fruits contained lower total, reducing and non-reducing sugars which were 7.74%, 3.98% and 3.76% , respectively. However navel orange fruits had higher pH value 3.70 and total soluble solids/ acid ratio (9:1) than that of balady orange fruit which were 3.6 and 7.2 : 1, respectively.

Table 1. Some chemical constituents and physical properties of fresh navel orange fruits.

Components	*Navel*
Juice yield%	*33.81*
Total soluble solids%	*10.98*
Total acidity% (as citric acid)	*1.22*
pH value	*3.70*
Ascorbic acid (mg/100gm)	*55.67*
β-carotene (mg/100gm)	*0.013*
Total sugars %	*7.74*
Reducing sugars %	*3.98*
Non-reducing sugars%	*3.76*
Total soluble solids/ acid ratio	*9:1*
Ash %	*0.45*
Minerals (mg/100gm)	
Na	*0.7*
P	*135.09*
K	*20.31*
Ca	*19.48*
Mg	*12.44*

* El-Ashwah et al., 1975.

Navel orange fruit processing :

A- Navel orange compote:

1- Changes in some chemical and physical properties of solution of immersion during storage.

From the results given in Table 2, it could be observed that the total soluble solids decreased through 15 days storage as well as it was lower in glucose solution compared to sucrose which may be due to the small molecular weight of glucose being more faster to transfer from the solution into the fruit compared to the larger melocular weight of sucrose. *(Raoult- Wack, 1994).* The interchange of total soluble solids was rapid at the first stage of storage, afterwhich its level was constant until 40 days of storage, then slightly decreased which may be attributed to the Maillard reaction. Total acidity as citric acid increased in all solutions except for orange juice solution. The highest increase in sucrose solution than that of glucose, caused autolysis and reaction between organic acid and glucose. These results agree with those reported by Van-Dam et al, 1986, who mentioned that the browning reaction was very active when glucose was present in the media. The increase in total acidity of solution was reflected by the reduction of the pH value.

2- Changes in The chemical and physical properties of naval orange compote during storage.

Table 3 reveals that processing caused high losses in the ascorbic acid content compared to the loss during storage at °5C. These losses could be due to the oxidation of ascorbic acid. Total sugars reached 4.41, 7.51, 9.08 and 7.63% in compote immersed in water, sucrose, glucose solutions once and naval orange juice through 7 days of storage. The high sugar content of the compote could be attributed to the faster soluble matters transfer from the solution into the Compote. These results agree with the findings of *(Raoult- Wack, 1994)*. Reducing sugars content steadly decreased after 15 days of storage, while non-reducing sugars remained nearly constant. This indicates that glucose had the main role in reactions taking place during storage. Prolonged storage as well as the type of immersing soulution had an affect on color of compte. The best results of color in a decreasing order were observed in water, sucrose and naval orange juice solution, respectively.

Table 2. Some chemical and physical changes of immersing solution during storage of navel orange compote at °5C.

Solution of Immersing	Parameters	Storage period of compote (days)						
		0	3	7	15	45	90	180
Water	TSS%	0.83	4.4	5.26	7.92	7.81	7.76	7.61
	TA%	0.03	0.26	0.58	0.88	0.85	0.83	0.81
	pH value	6.4	5.7	5.20	4.01	4.11	4.12	4.12
Sucrose 14%	TSS%	13.37	11.84	9.15	12.57	13.23	13.23	13.02
	TA%	0.06	0.33	0.64	0.97	0.95	0.93	0.90
	pH value	6.2	5.30	4.8	3.87	4.1	4.1	3.80
Glucose 14%	TSS%	13.03	10.42	8.16	10.70	13.20	13.21	12.58
	TA%	0.06	0.29	0.58	0.88	0.85	0.80	0.73
	pH value	6.4	5.7	5.13	4.09	4.11	4.11	4.35
Navel Orange Juice 10.98%	TSS%	10.87	10.83	10.80	10.75	10.75	10.62	10.51
	TA%	1.19	1.17	1.17	1.15	1.13	1.07	1.02
	pH value	3.65	3.65	3.64	3.60	3.60	3.81	3.80

TSS : Total soluble solids.
TA : Total acidity as citric acid.

Table 3. Some chemical constituents and physical properties of navel orange compote during storage at °5C.

Storage period (days)	Immersing solution	Ascorbic acid mg/100g	Total sugars %	Reducing sugars %	Non-Reducing sugars %	*Color index (O.D)*
0	Water	42.31	7.50	3.85	3.65	*0.002*
	Sucrose	40.27	7.85	3.97	3.75	*0.003*
	Glucose	40.03	7.86	4.21	3.45	*0.003*
	Orange juice	50.50	7.60	3.95	3.70	*0.005*
3	Water	40.31	6.73	3.42	5.31	*0.002*
	Sucrose	39.27	8.14	3.95	4.25	*0.003*
	Glucose	39.03	9.60	5.85	3.70	*0.004*
	Orange juice	48.00	7.69	3.93	3.70	*0.005*
7	Water	40.00	5.81	3.22	2.59	*0.002*
	Sucrose	39.01	8.51	3.83	4.78	*0.003*
	Glucose	39.00	10.08	3.38	3.72	*0.004*
	Orange juice	47.51	7.63	3.90	3.71	*0.005*
15	Water	40.000	4.71	2.52	2.29	*0.002*
	Sucrose	39.00	8.56	3.87	4.89	*0.003*
	Glucose	39.00	10.30	6.53	3.877	*0.004*
	Orange juice	47.42	7.03	3.63	3.40	*0.005*
90	Water	39.68	4.71	2.52	2.19	*0.002*
	Sucrose	38.70	8.47	3.63	4.86	*0.004*
	Glucose	38.31	9.23	5.43	3.80	*0.009*
	Orange juice	45.47	6.93	3.43	3.40	*0.007*
180	*Water*	*38.54*	*4.65*	*2.56*	*3.15*	*0.003*
	Sucrose	*36.48*	*8.41*	*3.56*	*4.85*	*0.007*
	Glucose	*35.70*	*9.09*	*5.32*	*3.77*	*0.019*
	Orange juice	*42.80*	*6.82*	*3.44*	*3.38*	*0.020*

O.D = Optical density at 420° um.

3- Effect of calcium chloride $CaCl_2$ on compote qualities and their solutions:

Pectic substances are considered among the main constituents of alcohol insoluble solids (AIS). One of these substances is the water soluble pectin WSP. Data in Table (4-a) show that the reduction in AIS content was concomitant with an increase in WSP content. The addition of $Cacl_2$ retarded the conversion of AIS into

WSP. It is known that calcium ion bind to the free carboxyl groups of the pectin-molecules. Thus forming Ca^{++} bridges with the free carboxyl groups of the pectin-molecules *(Pilink and Voragen, 1991)*, furthermore a decrease of tissue firmness could occur.

Table (4-a). Effect of calcium chloride addition ($Cacl_2$ 0.5%) on pectin fraction and firmness of navel orange compote during storage at 5°C.

Storage period (months)	Alcohol insoluble solids (AIS)		Water soluble pectin (WSP)%		*Firmness Lb/ Inch²*	
	1	2	1	2	1	2
0	*2.13*	*2.21*	*1.73*	*1.75*	*0.033*	*0.015*
3	*1.73*	*2.19*	*2.86*	*1.80*	*2.75*	*0.101*
6	*1.03*	*2.11*	*3.78*	*2.05*	*0.46*	*0.126*

1= Untreated samples.

2= Samples treated with 0.5% $Ca\ Cl_2$.

As for, turbidity of their solutions. It could be observed that the increase in WSP content of compote was accompanied by the increase in turbidity of solution (Table 4-b).

Table (4-b) Effect of calcium chloride addition on turibidity of sucrose solution during storage of navel orange compote at 5°C.

Storage months	Untreated	*Treated*
0	*0.02*	*0.02*
3	*1.23*	*0.72*
6	*1.13*	*0.70*

Turbidity at 660um.O.D.

4- Sensory evaluation of navel orange compote:

Data in table (5) show the sensory evaluation of navel orange compote after 180 days storage at 5°C. The scores of the overall acceptability were highest in the compote immerised in sucrose solution, followed by water and finally with navel orange juice and glucose solution, respectively. Color was dark in the compote dipped in glucose solution. It was noticed that the sucrose solution could be considered as the best dipping solution to produce an excellent grade of navel orange compote (*Mohamed et al., 2000*). Who stated that, no differences existed in sensory attributes between pear compote preserved in sucrose solution or in high fructose corn syrup.

B- Navel orange juice:

1- Effect of enzymatic treatments on some chemical and physical changes of navel orange juice.

Table 5. Sensory evaluation of navel orange compote

Sensory attributes / Dipping Treatment	Taste	Color	Flavour	*Overall acceptability*
Water	B 6.63	A7.33	AB 6.62	*A 7.91*
Sucrose 14%	A 7.52	B 6.01	A 7.91	*A 7.88*
Glucose 14%	C 5.85	C 5.83	A 6.88	*B 6.87*
Orange juice 10.98%	C 5.51	C 5.48	AB 8.90	*B 6.71*
L.S.D.	*0.720*	*0.92*	*0.90*	*0.76*

The percentage of juice yield, total soluble solids TSS and total acidity TA increased by about 17%,13%and 11%,respectively when the enzyme was used. This is in accordance with *(Pilink and Voragen, 1991)* who reported that a release of about 80% of polysaccharides occurred through cell walls treated with commercial pectolytic enzyme. The increase in T.A. was due to desterification of methylated pectin as a result of enzyme utilization. These results led to a decrease in pH value and viscosity (Table 6). Juice yield increased by using the enzyme into 41.93% to reach to the level usually found in case of balady orange juice *(El-Ashwah et al., 1975).*

As for total, reducing, non-reducing sugars, ascorbic acid and β-carotene, it was found that the addition of enzyme gave higher values as previously given in table (6). This would be due to the extraction of higher amounts of these compounds as a results of enzyme treatments. These results are in agreement with those reported by *(Pilink and Voragen, 1991).*

Table 6. Effect of enzymatic treatment on some chemical and physical changes of navel orange juice.

Components	Untreated	*Treated with USP enzyme*
Yield %	*33.81*	*41.93*
Total soluble solids%	*10.98*	*12.83*
Total acidity % (as citric acid)	*1.22*	*1.46*
pH value	*3.72*	*3.60*
Total sugars%	*7.74*	*9.77*
Reducing sugars%	*3.98*	*4.96*
Non-reducing sugars %	*3.76*	*4.81*
Ascorbic acid mg/100ml	*53.070*	*58.520*
B-carotene mg/100ml	*0.013*	*0.127*
Viscosity centipose	*7.31*	*3.52*
Color index	*0.30*	*0.37*

2- Effect of enzymatic treatment and juice sac on sensory evaluation of navel orange juice:

The statistical analysis showed a significant difference in taste, color, flavour and overall acceptability as a results of different treatments (table 7). Navel orange are rich in juice either the untreated and/or the treated with USP enzyme which gave high level of sensory grades. There were significant differences between samples treated with USP enzyme compared to the untreated sample (control).

From the above mentioned results, it could be concluded that the navel orange juice rich in juice sacs was more acceptable and preferred. Therefore, the addition of navel orange juice sacs to the juice would render it more popular and preferred as that of fresh orange fruit.

Table 7. Sensory evaluation of navel orange juice as affected by enzymatic treatment and juice sacs.

Treatments	Taste mean	Color mean	Flavor mean	*Overall-acceptability mean*
Control	C 5.1	B 7.3`	C5.2	*C6.21*
	AB	B	B	*B*
Control + juice sac	7.9	7.5	B6.73	*8.30*
	B	A	B	*B*
USP enzyme	7.3	8.60	6.90	*7.40*
	A	A	A	*A*
USP enzyme + juice sacs	8.2	8.66	8.70	*9.30*
L.S.D.	*0.831*	*0.965*	*0.850*	*0:973*

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طرق غير تقليدية لتصنيع ثمار البرتقال أبــو ســرة

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تهدف هذه الدراسة إلى تطوير تصنيع ثمار البرتقال أبو سرة لإنتاج كمبوت وعصير برتقــال غير تقليدي يحتوى على جيوب عصيرية. كما اشتملت الدراسة علــى تتبــع التغيــرات الكيميائيــة والفيزيائية والحسية المتأثرة بنوع محلول الغمر وكلوريد الكالسيوم والمعاملــة الأنزيميــة و إضــافة الجيوب العصيرية و ظروف التخزين على صفات الجودة للمنتج النهائي.

وقد أظهرت النتائج المتحصل عليها أن استعمال الانزيمات البكتنية التجارية قد أدى إلى زيادة إنتاج العصير وتحسين التركيب الكيميائى والصفات الحسية للعصير الناتج ووجــد أيضــا أن نســبة العصير الناتج باستعمال الانزيم مماثلة لنسبة العصير الناتجة من البرتقــال البلــدى. وأن إضــافة الجيوب العصيرية أدت إلى تحسين درجة تقبل العصير بالنسبة للمحكمين. ومــن نتــائج البحــث أن إضافة كلوريد الكالسيوم قد حسن من المحافظة على قوام الكمبوت أثناء التخزين.

وإتضح أيضا من الدراسة أن محلول الغمر لإنتاج الكمبوت المكون من السكريات الأحادية كان أسرع فى الانتقال للكمبوت بالمقارنة بالسكريات الثنائية والعديدة بالإضافة الى أن السكريات الأحادية أسرع تأثيراً على التركيب الكيميائي والخصائص الطبيعية والحسية فى الكمبوت.