Nutritional Evaluation of Some Products from Ber Fruits

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Abstract: Several nutritional products were produced from local and Chinese ber fruits such as (beverage, combot, jam, candied ber and syrup). The physicochemical constituents, vitamin C, phenolic content and antioxidant activity were determined. Also, minerals, color values and organoleptic properties were measured. The results showed that Chinese ber jam had high values of TSS% (72.87%), protein (3.34%), fat (0.91%) and ash (3.06%). The same trends were found for total solids (91.07%), pH (4.01)%, fiber (3.98)% Contents in Chinese candied ber. Acidity (as malic acid) and total sugars% reached to their maximum values in Chinese ber beverage and syrup being (2.41% and 70.61%) respectively. The contents of vitamin C, phenol and total antioxidant activity (DPPH%) ranged from 48.25-191.65mg/100g, 2.40-7.14mg GAE/gm and 76.95-89.95% respectively. Potassium and calcium were the most predominant minerals and ranged from (203.68-548.71mg/100g and (74.92-419.13mg/100g) respectively. Color results showed that there was a reduction in L (lightness) and a (redness) values for local and Chinese ber beverages and increment the same parameters for local and Chinese ber jams and it's saturation values compared to the other products while, candied ber samples prepared from two ber varieties had the highest hue values. High score values for the tested organoleptic properties were present in all ber products prepared from Chinese ber fruits. This research aimed to preparing several new products from ber fruits (local and Chinese) varieties such as beverage, combot, jam, dried candy and syrup also, study the nutritional analysis and sensory characteristics for these products.
[Helmy, I. M. F., Wafaa, M. Abozied and Nadir, A **Nutritional Evaluation of Some Products from Ber Fruits]** Nat Sci 2012;10(8):37-46]. (ISSN: 1545-0740). http://www.sciencepub.net/nature. 7

Keywords: Beverage, combot, jam, candied ber and syrup

1. Introduction

The jujube or ber (Ziziphus spp.), which is mainly distributed in the subtropical and tropical regions of Asia and America, is a tree of rhamnaceae family. Jujube fruits in the Mediterranean region have various shapes, sizes, colors and tastes and have been reported to posses unique nutritional and organoleptic characteristics (Akbolat *et al.,* 2008). Chinese jujube (Ziziphus jujube Miller) is indigenous to China with a history of over 4000 years. It has been widely planted in reforested areas within the Yellow River valley, and chosen as a variety compatible with the present ecology and economy (Yan and Gao, 2002). The fruit of Chinese jujube is favoured and profitable fruit, and is much admired for its high nutritional value (Wei *et al.,* 2005 and Li *et al.,* 2007 and 2009). It has been commonly used as a crude drug in traditional Chinese medicine for the purpose of analeptic, palliative, antibechic, hypoglycemic and antihyperglycemic (Glombitza *et al.,* 1994 and Zakaria *et al.,* 1999) and also additive and flavourant for thousands of years (Su and Liu,2005and Li *et al.,* 2007). Much of the annual Chinese jujube production has been consumed in fresh and dried forms, therefore, there are numerous studies, experimental works as well as simulations, dealing with preservation of jujube and drying to enhance quality (Wu *et al.,* 2001, Wang *et al.,* 2003 and Jiang *et al.,* 2004).

Fresh mature ber fruits contains 81 to 97% pulp (Hovatia *et al.,* 1993 and Ghosh and Mathew, 2002). Ber pulp contains 12-23% T.S.S., 0.13-1.42% acidity, 3.1-14.5% total sugars, 1.4-9.7% reducing sugars (Ghosh and Mathew, 2002). Ber pulp is a rich source of vitamin C and the ascorbic acid content in different ber cultivars ranged from 39-166 mg/g of pulp. The contents of DPPH radical and total phenolic mg GAE/gm in some cultivars of Chinese jujube fruits ranged between 33.60-98.60% and between 5.18-8.53 mg GAE/gm respectively. The fruit taste like a mixture of dates and apples and are highly prized by the Bedouins were found to have a very energy value (Gultekin, 2007). The food from this plant is an important source of energy, protein and minerals (Li *et al.,* 2007).

The fresh fruit has a mild sub-acid flavor and crisp firm flesh, it can also be eaten boiled as an addition to rice or millet, stewed or baked. Other culinary uses include preparation of pickles, jams, candied fruits, beverages, ber butter and cheese –like pastes (Pareek,2001,2002 and Azam Ali *et al.,* 2006).

Shin *et al.* (1992) investigated various processing methods for Z. jujube fruits. Based on sensory evaluation and chemical analysis, it was found that dried fruits, nectar, jam, fruit extracts and a powdered tea were the most promising products.

Dawney *et al.* (2002) found that the best recipe for ber jam included 750 g sugar per kg pulp and with an acidity of 0.75%.

2. Material and Methods

Material:

Ripe fruits of local ber variety (*Zizyphus spina-Christi L.*) and Chinese ber variety (*Ziziphus jujube Miller.*) were obtained from local market. The fruits were washed, packed in plastic bags and stored in refrigerator at 5±1°C until used. 2.2-diphenyl-1-picrylhudrazi (DPPH) and gallic acid were purchased from Sigma Chemical Co.

Methods:

Preparation of different products from ber fruits:

Fig. (1): Flow diagram for ber beverage production (Pareek, 2001).

Fig. (2): Flow diagram fore ber combot production (Pareek,2001).

Fig. (3): Flow diagram for ber jam production (Dawney *et al.,* 2002).

Fig. (4): Flow diagram for candied ber and ber syrup production (California Rare Fruits Growers, 1996).

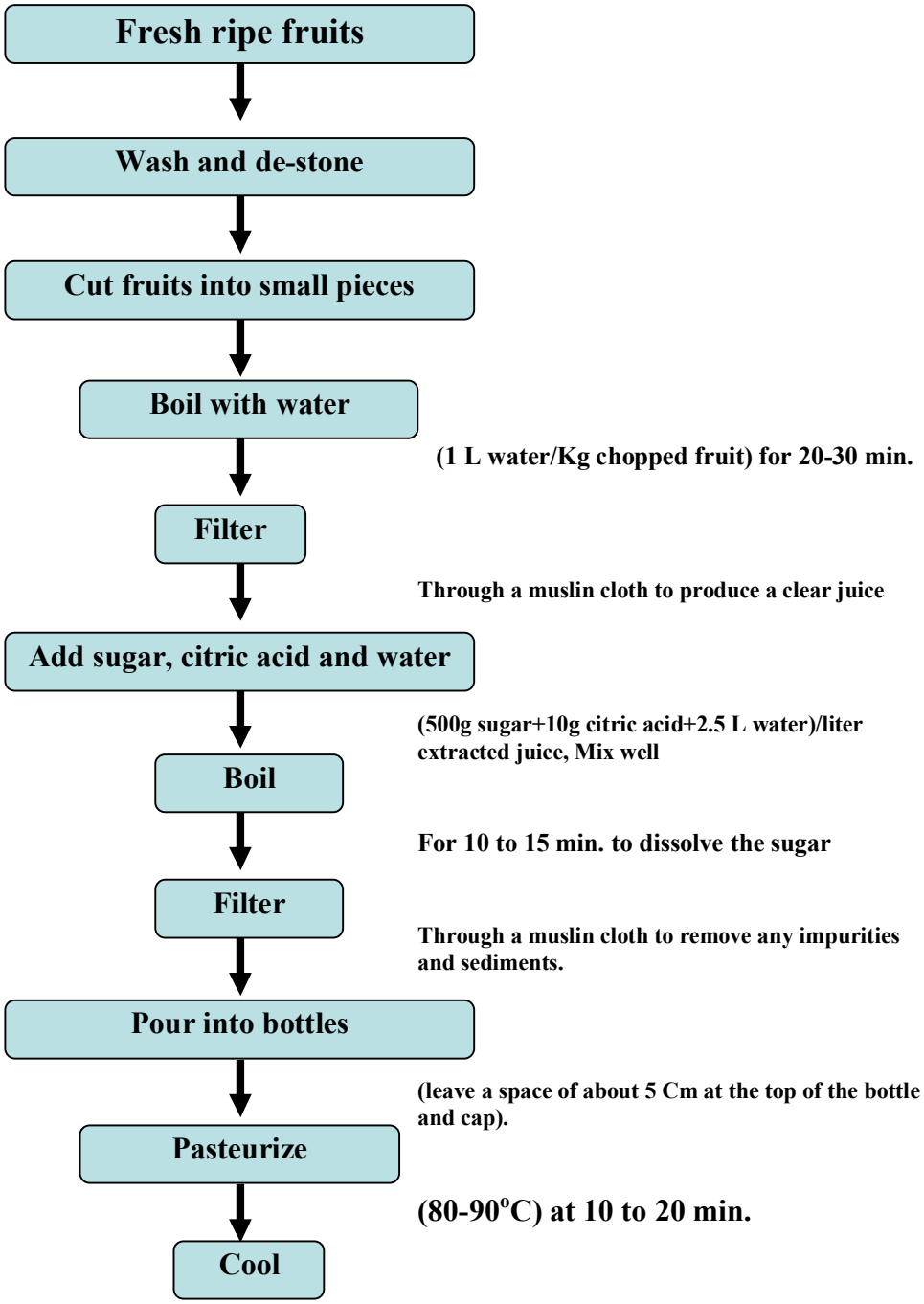

Fig. (1): Flow diagram for ber beverage production (Pareek, 2001)

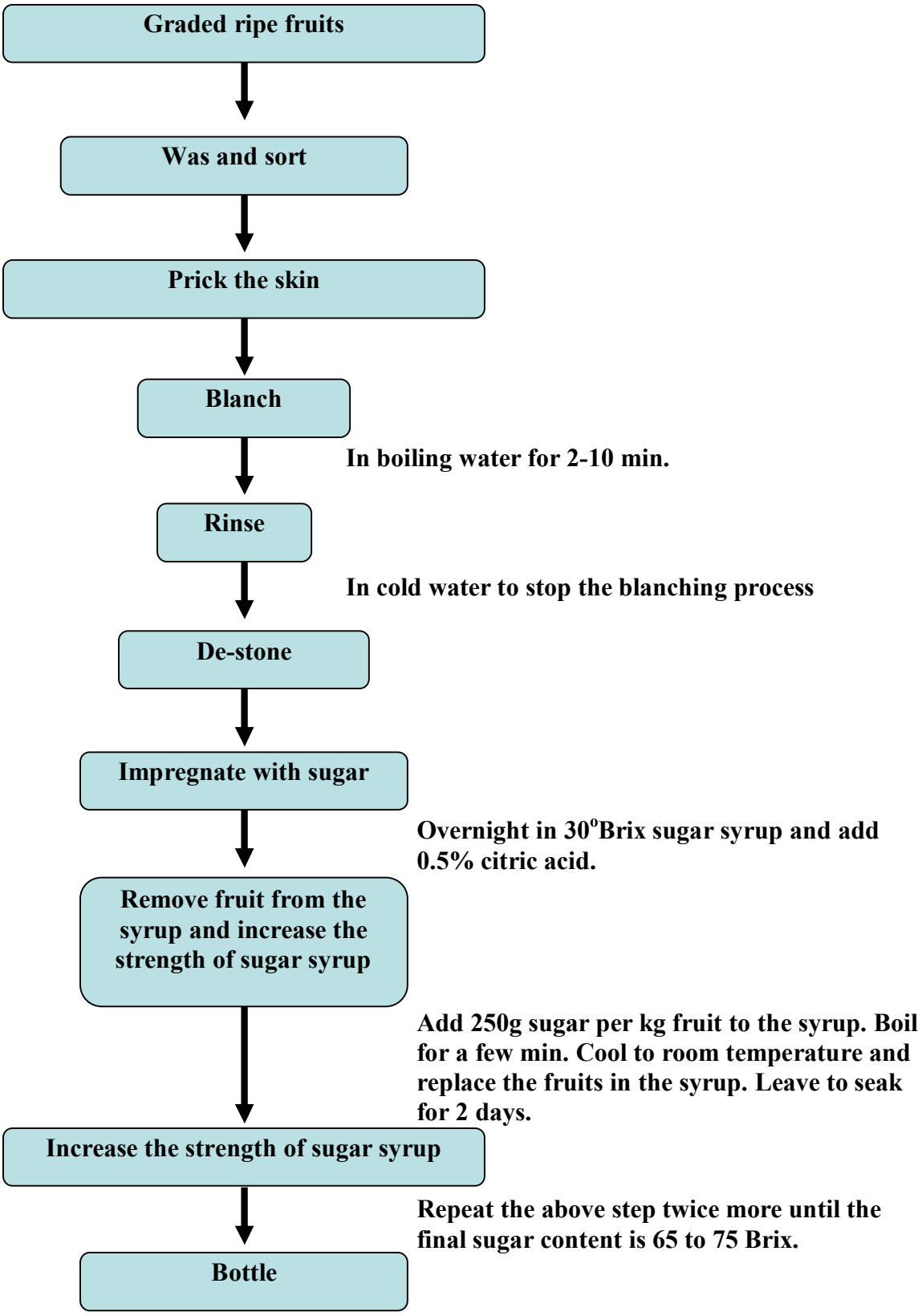

Fig. (2): Flow diagram for ber combot production (Pareek, 2001)

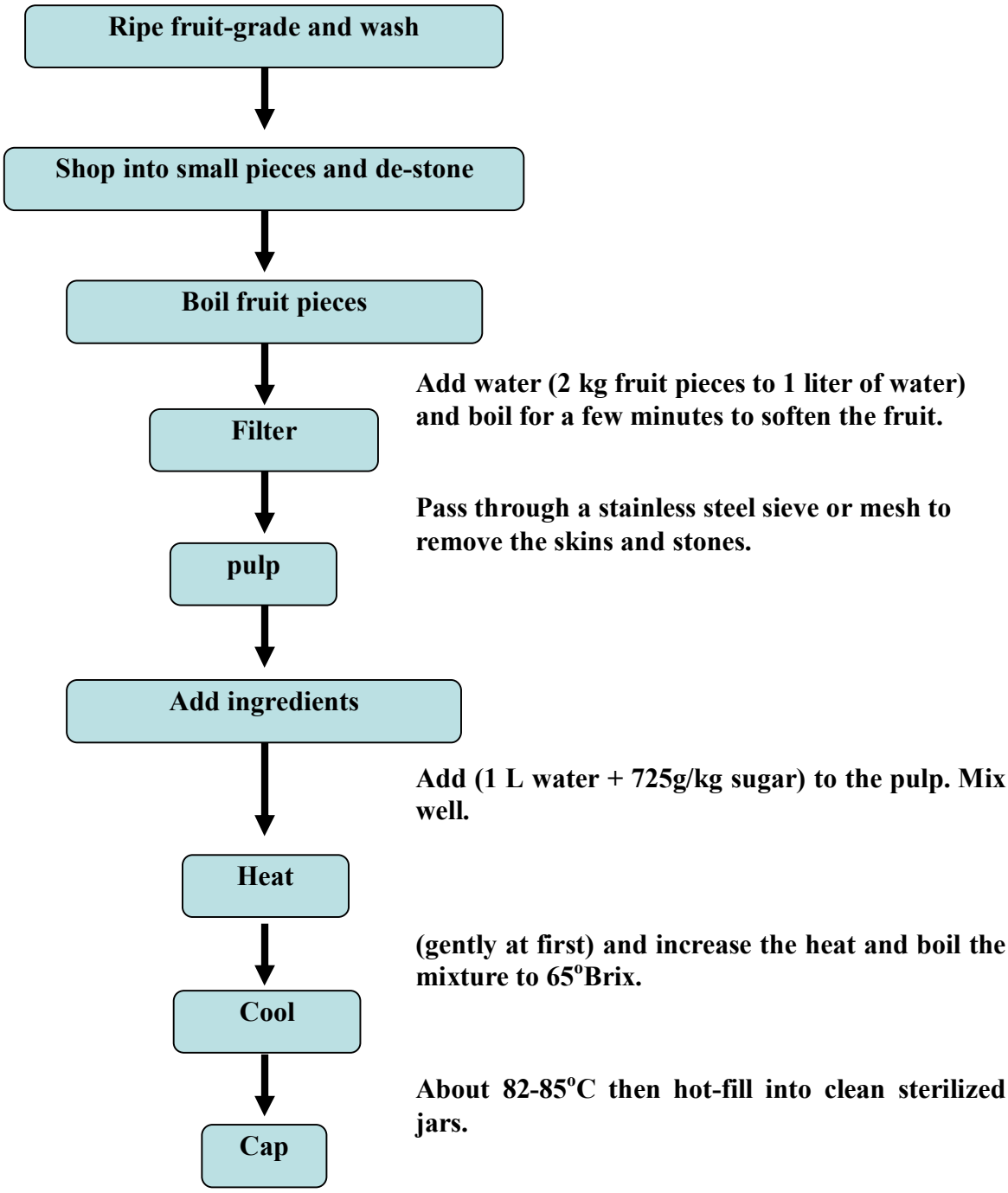

Fig. (3): Flow diagram for ber jam production (Dawney *et al.*, 2002)

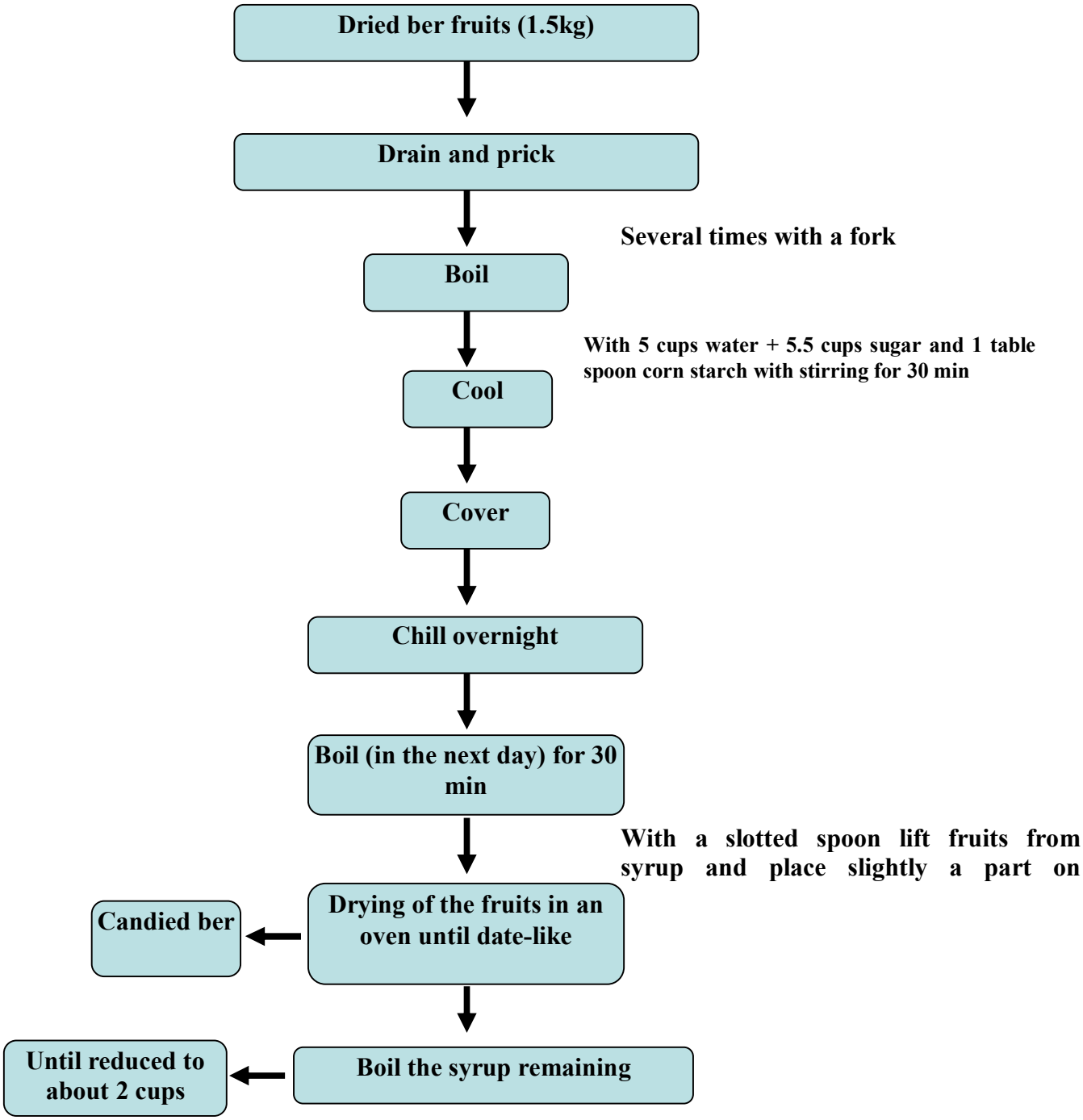

Fig. (4): Flow diagram for candied ber and ber syrup production (California Rare ruit Growers, 2001)

Analytical methods:

Moisture, protein, fat, fiber, ash, total solids, total acidity, total soluble solids (TSS%), pH, total sugars, reducing sugars, minerals and vitamin C were determined according to the A.O.A.C. methods (2005). Non-reducing sugars was determined by difference.

Determination of total phenolic compounds:

The total phenolic compounds of fruit extracts were determined according to the method described by Singletion *et al.* (1999).

Determination of total antioxidant activity:

The antioxidant of the ethanolic extracts was determined on the basis of their scavenging activity for the stable 2, 2-diphenl-1- picrylhydrazil (DPPH) free radicals following the method described by Bozin *et al.*(2006).

Color evaluation:

Color values were measured using Hunter-Scotfield's equation (Hunter, 1975) as follows:

$$\text{Saturation index} = \sqrt{a^2 + b^2}$$

Hue angle = ($tg^{-1}b/a$)
Where a and b are redness and yellowness values.

Sensory evaluation:

Sensory evaluation for beverage (appearance, color, taste, flavour, viscosity and overall acceptability), combot (color, taste, flavour, texture and acceptability), jam (color, taste, texture and preference), candied ber (appearance, color, taste, flavour, texture and overall acceptability) and syrup samples (appearance, color, taste, flavour and viscosity) were evaluated as described by Faridi and Rubenthaler, (1984) and were made by 10 semi-trained from Food Science and Technology Department, Staff, NRC.

Statistical analysis:

The results obtained were analyzed using one-way ANOVA for mean differences. The *P*-values of < 0.05 was considered significant and data were expressed as mean ± standard deviation (SD).

3. Results and Discussion

Data shown in Table (1) indicated that total soluble solids were increased in Chinese ber jam compared with those of other ber products. The highest value for pH was 4.01 for Chinese candied ber while, its lowest value was 3.33 for Chinese ber jam. Local and Chinese ber beverage contained 2.39 and 2.41% total acidity respectively (as malic acid) but, local and Chinese candied ber had 1.45% and 1.56% total acidity respectively. Total solids were reached to 91.07% in Chinese candied ber and represented the highest value compared to other products. Total and reducing sugars contents were 70.61% and 63.26% respectively in Chinese ber syrup. The results also showed that all ber products produced from local or Chinese ber fruits contained 1.16-3.34% protein, 0.15-0.91% fat, 0.95-3.98% fiber and 0.74-3.06% ash. High values of vitamin C (55.65 and 191.65) mg/100gm were present in local and Chinese ber beverage respectively. There was a great change in results of total phenolic and antioxidant activity DPPH values in different ber products reaches their maximum rate in local and Chinese ber beverage being (3.28 and 7.14) mg GAE/g dry weight and 81.15 and 89.95%, respectively. From the above results, several changes were noticed in all physicochemical constituents of different ber products (beverage, combot, jam, candied ber and syrup) compared to the same constituents in local and Chinese ber fruits as reported by Li *et al.* (2009) and Abozeid *et al.* (2011). Also, Wei *et al.* (2005) reported that total phenolic content GAE (mg/g) and antioxidant activity DPPH% were ranged from 5.18-8.53 mg GAE/g and 33.60-98.60% respectively for the different cultivars of Chinese ber fruits. The reduction in their constituents of different ber products in this research may be due to exposure to heat treatment during processing. These results are in agreement with those reported by Pareek (2001 and 2002) and Dawney *et al.* (2002).

Mineral contents of different products made from local or Chinese ber fruits are presented in Table (2). Results showed that combot samples prepared from local and Chinese ber fruits had higher contents of all investigated minerals than other products. Also, manganese and copper were the lowest values (1.19 and 0.61mg/100g) percent in local and Chinese combot samples respectively while, potassium (537.46 and 548.71mg/ 100g) was the highest values found in the same samples. Low mineral contents such as iron (1.99mg/100g), sodium (4.49mg/100g), potassium (203.68mg/100g), manganese (0.47mg/100g), phosphorus (14.34mg/ 100g) and copper (0.51mg/100g) were percent in local ber jam sample, calcium (74.92mg/100g) was found in Chinese ber jam sample and zinc (0.33mg/100g) was percent in Chinese ber syrup sample compared with those found in other ber products. Finally, as a general observation, potassium and calcium were the most predominant minerals ranged from 203.68 to 548.17mg/100g and 74.92 to 419.13 mg/100g respectively percent in different ber products investigated. These results are in agreement with those reported by Pareek (2002) and Azam-Ali *et al.*(2006). Similar results were noticed by Li *et al.* (2007).

Hunter color values of local and Chinese ber products are shown in Table (3). Results indicated that the values of lightness (L), redness (a) and yellowness (b) ranged between 42.71-64.50, 8.55-16.43 and 15.91-34.29 respectively where, Chinese ber jam sample had the highest color values compared to other ber products. Values of (L), (a) and (b) were low in Chinese ber beverage, syrup and combot samples (42.71, 8.67 and 13.51) respectively. Local and Chinese combot samples had higher values of a/b and lower values of hue compared to other local and Chinese ber products. a/b values decreased in local and Chinese candied sample to (0.36 and 0.39) respectively which represented the lowest values in all different ber products investigated. Saturation values of

local and Chinese ber jam increased to 33.39 and 38.02 and the increment levels ranged from 13.19 to 74.27% and from 40.30 to 121.43% for local and Chinese ber products respectively. The same trends of results was stated by Wan *et al.* (2003) , Wang *et al.* (2003) and Pareek (2001 and 2002).

Organoleptic properties of different ber products were statistically analyzed Tables (4-8). The obtained results from Table (4) indicated that, two samples of beverage prepared from both ber fruits (local or Chinese) contained a significant differences at ($P \leq 0.05$) in all determined organoleptic properties except the appearance property. The same trend for the last sensory results was observed for increasing all values of sensory properties of beverage sample prepared from Chinese ber fruits and it's total score was (94.45).

Table (1): Physico-chemical constituents of different ber products

Constituents	Beverage		Combot		Jam		Candied ber		Syrup	
	Local	Chinese	Local	Chinese	Local	Chinese	Local	Chinese	Local	Chinese
Total soluble solids (TSS)%	38.88±0.57	39.85±0.71	43.87±0.81	44.95±0.67	70.93±0.92	72.87±0.89	---	---	68.54±0.51	70.79±0.61
pH value	3.85±0.11	3.96±0.13	3.65±0.14	3.91±0.14	3.60±0.13	3.33±0.18	3.95±0.41	4.01±0.31	3.75±0.33	3.92±0.28
Acidity % (as malic acid)	2.39±0.12	2.41±0.11	2.10±0.09	2.37±0.11	1.51±0.11	1.73±0.14	1.45±0.21	1.56±0.19	1.53±0.15	1.67±0.14
Brix/acidity ratio	16.27±0.21	16.54±0.71	7.41±0.31	6.85±0.32	46.97±0.57	42.12±0.91	---	---	44.79±0.88	42.39±0.75
Moisture %	64.37±0.37	65.40±0.69	90.28±1.25	88.35±0.1.22	27.54±0.28	25.08±0.58	9.54±0.81	8.93±0.71	29.45±0.65	27.65±0.57
Total solids %	35.63±0.38	34.60±0.61	9.72±0.76	11.65±0.91	72.46±0.78	74.92±0.72	90.46±0.21	91.07±1.22	70.55±0.71	72.35±0.75
Total sugars %	36.29±0.41	38.47±0.51	41.58±0.81	43.67±0.79	67.80±0.58	69.48±0.66	60.25±0.81	62.33±0.71	68.33±0.87	70.61±0.72
Non-reducing sugars%	20.98±0.31	19.87±0.41	17.43±0.75	18.29±0.78	34.06±0.68	33.75±0.42	7.84±0.25	7.71±0.28	7.18±0.45	7.35±0.82
Reducing sugars %	15.31±0.25	19.60±0.33	24.15±0.51	25.38±0.41	33.74±0.42	35.91±0.41	52.41±0.51	54.42±0.48	61.15±0.57	63.26±0.67
Protein%	2.73±0.21	2.95±0.13	2.67±0.14	2.93±0.12	2.57±0.22	3.34±0.13	2.68±0.11	2.87±0.15	1.61±0.12	1.69±0.15
Fat%	0. 32±0.02	0.41±0.11	0.28±0.10	0.31±0.11	0.72±0.09	0.91±0.11	0.30±0.10	0.38±0.11	0.15±0.11	0.19±0.11
Fiber%	1.10±0.01	1.05±0.21	1.09±0.11	1.06±0.31	3.92±0.35	3.00±0.21	3.85±0.22	3.98±0.21	0.95±0.13	1.11±0.12
Ash%	0.77±0.03	0.85±0.15	0.86±0.11	0.79±0.21	2.62±0.21	3.06±0.28	1.54±0.14	2.89±0.13	0.74±0.18	0.81±0.15
Vitamin C (mg/10gm)	55.65±0.78	191.65±0.1.20	50.52±0.87	188.31±1.28	49.34±0.79	178.59±1.22	51.31±0.44	168.42±0.27	48.25±0.81	167.33±0.41
Phenolic content GAE (mg/gm)	3.28±0.11	7.14±0.21	3.11±0.31	6.94±0.21	2.95±0.22	6.53±0.42	2.81±0.12	6.44±0.25	2.40±0.11	5.91±0.35
Antioxidant activity DppH%	81.15±0.72	89.95±0.81	80.58±0.85	88.61±0.78	79.69±0.78	87.31±0.99	78.65±0.86	88.21±1.14	76.95±1.11	85.44±1.21

*Values present mean ± standard Deviations calculated from three replicates.

Table (2): Minerals contents of different ber products

Minerals (mg/100gm)	Beverage		Combot		Jam		Candied ber		Syrup	
	Local	Chinese	Local	Chinese	Local	Chinese	Local	Chinese	Local	Chinese
Sodium	6.15	7.72	11.89	11.65	4.49	5.59	10.91	11.48	6.61	7.85
Potassium	225.25	245.51	537.46	548.71	203.68	251.87	515.31	537.75	228.11	255.22
Calcium	137.27	105.89	419.13	167.80	155.83	74.92	398.91	157.54	128.88	95.12
Zinc	0.82	0.38	2.30	1.05	0.90	0.45	1.98	0.92	0.75	0.33
Manganese	0.91	39.87	1.19	80.63	0.47	35.72	0.88	37.56	0.97	40.25
Phosphorus	18.79	85.21	36.95	179.41	14.34	81.98	35.11	165.59	17.87	82.95
Iron	1.99	5.42	5.43	13.56	2.07	6.12	4.94	12.88	2.02	5.90
Copper	0.88	0.34	1.31	0.61	0.51	0.29	1.25	0.55	0.79	0.32

Table (3): Color values for different products produced from two different ber verities.

Samples	L	a	b	a/b	Saturation	Hue
Beverage (local)	44.92	8.55	18.11	0.47	20.03	64.73
Beverage (Chinese)	42.71	9.12	17.64	0.52	19.86	62.66
Combot (local)	52.91	12.43	17.18	0.72	21.21	54.11
Combot (Chinese)	49.73	10.60	13.51	0.78	17.17	51.88
Jam (local)	60.86	14.75	29.96	0.49	33.39	63.79
Jam (Chinese)	64.50	16.43	34.29	0.47	38.02	64.40
Candied ber (local)	59.12	10.11	27.71	0.36	29.50	69.96
Candied ber (Chinese)	57.10	9.75	25.29	0.39	27.10	68.92
Syrup (local)	46.24	9.17	16.82	0.55	19.16	61.40
Syrup (Chinese)	45.46	8.67	15.91	0.54	18.12	61.41

Table (4): Sensory properties of beverage samples produced from two different ber varieties.

Organoleptic Properties	Beverage samples prepared from two different ber varieties		LSD 0.05
	Local	Chinese	
Appearance (15)	13.81±0.35	14.40 ±0.31	n.s
Color (20)	16.45^{b}±0.37	18.79^{a}±0.39	2.25
Taste (20)	17.25^{b}±0.28	19.13^{a}±0.30	1.75
Flavour (15)	12.62^{b}±0.22	13.92^{a}±0.25	1.28
Viscosity (15)	12.70^{b}±0.33	13.85^{a}±0.27	1.12
Overall Acceptability (15)	13.9^{b}±0.41	14.36^{a}±0.29	1.15
Total (100)	**86.02**	**94.45**	

*Values represent means ± standard deviations calculated from three replicates.
*Means with different letters within a raw are significantly different at ($P \leq 0.05$)

From table (5) results show that, the highest score (47.95) for all organoleptic properties was found in combot sample produced from Chinese ber fruits. Chinese combot sample had higher values of some organoleptic properties such as color, flavour and acceptability being 9.68, 9.46 and 9.75, respectively than the same properties of local combot sample. There was a significant differences ($p \leq 0.05$) between the two different combot samples for color, flavour and acceptability and vise versa in taste and texture for the same samples.

Data in table (6) revealed that Chinese jam sample recorded high values of all organoleptic properties compared to local jam sample where its score reached 38.31 and had a significant differences ($P \leq 0.05$) in all determined organoleptic properties with local sample.

From table (7), it could be seen that, Chinese candied ber samples the highest score (92.32) and significant differences ($P \leq 0.05$) for color, appearance, taste and texture compared with those of its local sample. It was observed that the values of the last properties were high in candied ber sample prepared from Chinese fruits and the same trends was noticed in results of flavour and overall acceptability of Chinese candied ber sample but without significant differences percent between the last sample and local candied ber sample.

Sensory evaluation of different syrup samples was statistically analyzed as shown in Table (8). Results show that, the tested organoleptic properties in syrup sample prepared from Chinese ber fruits increased and reached to 18.65, 19.32, 19.20, 18.76 and 18.51 for appearance, color, taste, flavour and viscosity, respectively and with higher score being 94.44. Finally, it could be concluded that several ber products could be prepared using local or Chinese ber fruits with good acceptable sensory properties.

Table (5): Sensory properties of combot samples produced from two different ber varieties.

Organoleptic Properties	Combot samples prepared from two different ber varieties		LSD 0.05
	Local	Chinese	
Color (10)	9.45^{b}±0.14	9.68^{a}±0.11	0.22
Taste (10)	9.37^{b}±0.15	9.52^{a}±0.16	n.s
Flavour (15)	9.08^{b}±0.14	9.46^{a}±0.12	0.39
Texture (10)	9.26^{b}±0.15	9.54^{a}±0.13	n.s
Acceptability (10)	9.34^{b}±0.15	9.75^{a}±0.16	0.38
Total (50)	**46.50**	**47.95**	

*Values represent means ± standard deviations calculated from three replicates.
*Means with different letters within a raw are significantly different at ($P \leq 0.05$)

Table (6): Sensory properties of jam samples produced from two different ber varieties.

Organoleptic Properties	Jam samples prepared from two different ber varieties		LSD 0.05
	Local	Chinese	
Color (10)	9.26 [b]±0.12	9.53 [a]±0.17	0.26
Taste (10)	9.34 [b]±0.11	9.67 [a]±0.14	0.31
Texture (10)	9.17 [b]±0.13	9.49 [a]±0.15	0.32
Preference (10)	9.29 [b]±0.14	9.62 [a]±0.17	0.33
Total (40)	**37.06**	**38.31**	

*Values represent means ± standard deviations calculated from three replicates.
*Means with different letters within a raw are significantly different at ($P \leq 0.05$)

Table (7): Sensory properties of candied samples produced from two different ber varieties.

Organoleptic Properties	Candied samples prepared from two different ber varieties		LSD 0.05
	Local	Chinese	
Appearance (15)	12.94 [b]±0.25	13.57 [a]±0.29	0.62
Color (20)	16.83 [b]±0.31	18.61 [a]±0.41	1.76
Taste (20)	16.45 [b]±0.35	17.74 [a]±0.24	1.25
Flavour (15)	13.51 [b]±0.27	13.98 [a]±0.22	n.s
Texture (15)	13.90 [b]±0.41	14.62 [a]±0.33	0.69
Overall Acceptability (15)	13.35 ±0.37	13.80 [a]±0.30	n.s
Total (100)	**86.98**	**92.32**	

*Values represent means ± standard deviations calculated from three replicates.
*Means with different letters within a raw are significantly different at ($P \leq 0.05$)

Table (8): Sensory properties of syrup samples produced from two different ber varieties.

Organoleptic Properties	Candied samples prepared from two different ber varieties		LSD 0.05
	Local	Chinese	
Appearance (20)	16.49 [b]±0.22	18.65 [a]±0.27	2.11
Color (20)	17.28 [b]±0.30	19.32 [a]±0.31	1.98
Taste (20)	16.68 [b]±0.33	19.20 [a]±0.25	2.48
Flavour (20)	17.10 [b]±0.21	18.76 [a]±0.29	1.65
Viscosity (15)	16.34 [b]±0.39	18.51 [a]±0.35	2.11
Total (100)	**83.89**	**94.44**	

*Values represent means ± standard deviations calculated from three replicates.
*Means with different letters within a raw are significantly different at ($P \leq 0.05$)

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References

1. A.O.A.C. (2005). Official Methods of Analysis of AOAC International 18th Ed., AOAC International, Gaithersburg, MD, USA.
2. Abozeid, W.M.; Helmy, I.M.F.; Nadir, A. and Abou-Arab, E.A. (2011). Production and development of new products from local and Chinese ber fruits. Australian Journal of Basic and Applied Sciences, 5(6): 652-659.
3. Akbolat, D.; Ertekin, C.; Menges, H.O.; Ekinci, K. and Erdal (2008). Physical and nutritional properties of jujube (Zizyphus jujube Mill.) growing in turkey. Asian J. Chem., 20, 757-766.
4. Azam-Ali, S.; Bonkoungou, E.; Bowe,C.; Dekock, C.; Godara, A. and Williams, J. (2006). Harvesting post-harvest handling and processing in: Ber and other jujubes, eds. Williams, J.; Smith, R.W.; Haq, N. and Dunsiger, Z., international centre for underutilised crops, university of Southampton, Southampton, UK. 113-153.
5. Bozin, B., Mlmica-Dukic, N., Simin, N. and Anackov, G. (2006). Charact-erization of the volatile composition of essential oils of some lamiaceae spices and the antimicrobial and the antioxidant activities of the entire oils. J. Agric. Food Chem., 54: 1822-1828.
6. California Rare Fruit Growers (1996**). JUJUBE**
7. .Htpp://www.crfg.org/pubs/jujube. html.
8. Dawney, Thomas and Kulwal, L.V. (2002). Preparation of jam from ber fruits (*Ziziphus mauritiana L.*). Indian Food Packer, January-February, 57-59.

9. Faridi, H. A. and Rubenthaler, G. L (1984). Effect of baking time and temperature on bread. Cereal Chemistry, 61(2): 151-154.
10. Ghosh, S.N. and Mathew, B. (2002). Performance of nine ber (*Zizphus mauritiiana Lamk*) cultivars on topworking in the semi-aried region of west Bengal. J. Appl. Hort. 4(1): 49-51.
11. Glombitza, K.W.; Mahran, G.H.; Mirhom, Y.W.; Michel, K.G. and Motawi, Y.K. (1994). Hypoglycemic and antihypoglycemic effect of Z. *spina-christi* in rats. Planta Medica, 60(3):244-247.
12. Gultekin, H.C.(2007). An unknown fruit (jujube). Popular Sci. J., 11: 41-43.
13. Hovatia, R.S.; Patel, D.S. and Patel, G.V.(1993). Performance of ber (*Zizphus mauritiiana Lamk*) cultivars under dried conditions. Annals Arid Zone, 32(4): 215-217.
14. Hunter, R. S. (1975). Scales for measurements of color differences. In Measurement of Appearance, J. Wiley Ed., P. 133. Interscience, New York.
15. Jiang, W.B.; Sheng, Q.; Jiang, Y.M. and Zhou, X.Y.(2004). Effect of 1-methylcyclopropene and gibberellic acid on ripening of Chinese jujube (Zizyphus jujube M.) in relation to quality. Journal of the Science of Food and Agriculture, 84(1):31-35.
16. Li, H., Li, F., Wang, L., Sheng, J., Xin, Z., Zhao, L., Xiao, H., Zheng, Y. and Hu, Q. (2009). Effect of nano-packing on preservation quality of Chinese-Jujube (*Ziziphus jujube* Mill. Var. inermis (Bunge) Rehd). Food Chemistry, 114, 547-552.
17. Li, J.W.; Fan, L.P.; Ding, S.d. and Ding, X.L. (2007). Nutritional composition of five cultivars of Chinese jujube. Food Chemistry, 103: 454-460.
18. Pareek, O. P .(2001). Fruits for the Future 2: Ber. International Centre for Underutilized Crops, University of Southampton, Southampton, U.K.
19. Pareek, O. P. (2002). Ber-ziziphus Mauritania. Available by International centre for underutilized crops (on line). Available: http://www. civil.soton.ac.uk/icuc/cd-icuc-ber-tamarind/content/ber/ber-book-html via the INTERNET. Accesed 2004 Apr. 6.
20. Shin, Y.Y.; Yun, M.S.; Kim, Y.S. and Lee, K.K.(1992). A study on the processing suitability of pear and Chinese jujube cultivars. Research reports of the rural development administration, farm Management, agriculture Engineering Sericulture& Farm Products Utilization 34(1): 58-65.
21. Singleton, V. L., Orthofer, R. M. and Ramuela-Raventions, R. M. (1999). Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. Methods in Enzymology, 299: 152-178.
22. Su, P.X. and Liu, X.M. (2005). Photosynthetic characteristics of linza jujube in conditions of high temperature and irradiation. Scientia Hortculture, 104: 339-350.
23. Wan, Y.K.; Tian,S.P. and Qin, G.Z. (2003). Enhancement of biocontrol activity of yeasts by adding sodium bicarbonate or ammonium molybdate to control postharvest disease of jujube fruits. Letters in Applied Microbiology, 37(3): 249-253.
24. Wang, J. Li, L. T. and Dan, Y. (2003). The correlation between freezing point and soluble solids of fruits. Journal of Food Engineering, 60 (4): 481-484.
25. Wei, L. J., Shao-Dong, D. and Xiao-Lin, D. (2005). Comparison of antioxidant capacities of extracts from five cultivars of Chinese jujube. Process Biochemistry, 40: 3607-3613.
26. Wu, C.E.; Wang, W.S. and Kou, X.H. (2001). Effect of $cacl_2$ and 6-BA on postharvest respiratory intensity and storage quality of Chinese jujube. Scientia Agricultura Sinica, 34(1):66-71.
27. Yan, Y.H. and Gao, Z.P. (2002). Industrialization of Chinese jujube. Journal of Northwest science and technology University of Agriculture and Foresty, 30(12): 95-98.
28. Zakaria, M.N.M.; Isalm, M.W.; Radhakrishnan, A.; Ismail, M.; Habibullah and Chan, K.(1999). Antidiabetic properties of Zizyphus spinachristi in STZ-Diabetic mice."2000 years of natural products research-past, present and future", Amsterdam, July 26-30.

5/28/2012