EVALUATION OF NEW NON-TRADITIONAL PRODUCTS PROCESSED FROM CAPE GOOSEBERRY (*PHYSALIS PERUVIANA* L.)

REDA A. AAMER

Hort. Crop Technology Res. Department, Food Technology Research Institute, A.R.C., Egypt

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Abstract

Cape gooseberry (*Physalis peruviana,* L.) is considered to be a very promising horticultural crop known in Egypt as Harankash as well as gaining popularity in the specialty markets. Currently it is usually used for local consumption in Egypt as a snack food. Therefore this current research aimed to utilize such crop by preparing and evaluating some food products such as canned compote, dehydrated fruits, nectar, syrup, paste, jam and appetizers. General characteristics, physical, chemical and technological properties**,** and some bioactive compounds of cape gooseberry (*Physalis peruviana,* L.) were investigated. The cape gooseberry pulp has a light sweet taste (TSS 13.75) with acidic nature (pH 3.7 and titratable acidity was 1.20 % as citric acid), Non reducing sugars represented about (52.95 %) of the total sugars which were (56.24%). The results also indicated that cape gooseberry can be considered as good source ß-carotene, vitamin C, total phenolic content, flavonoid contents and antioxidant activity in addition to some minerals such as potassium, magnesium, iron and zinc. The cape gooseberry (*Physalis peruviana,* L.) was used to formulate some important functional foods. The organoleptic properties of all processed products in this study were well palatable among different panelists.

Keywords*: Cape gooseberry (Physalis peruviana,* L.*), snack food, bioactive compounds physical, chemical, technological and sensory properties.*

INTRODUCTION

Development consumer demand for new crops as a purpose of diversification, especially if it can be used for different purposes i. e., local consumption, exportation and processing (Abeer, 2016). Also, today's consumers are very interested in the potential benefits of nutritional support for disease control or prevention through consuming healthy diet (Hassanien, 2011).

Cape gooseberry (*Physalis peruviana,* L.) is one of the important 100 species in the *Physalis* genus of the *Solanaceae* family. *Physalis* is included in the priority list of many governments' horticulture and fruit export plans. It is relatively unknown in importing markets and remains an exotic fruit. The important step toward developing *Physalis* as a commercial crop was maximizing its technological applications (El-Sheikha *et al*., 2009)

Cape gooseberry (*Physalis peruviana,* L.) is a very promising horticultural crop also known as poha, golden berry, Husk tomato, tomatillo, alkekengi, ground cherry and commonly known in Egypt as Harankash, this fruit is gaining popularity in the specialty markets. It is grown not only as a fruit which is eaten raw or as a dessert, jams, dehydrated fruits, sauces, appetizers, salads, cooked dishes, natural snacks and sometimes it is canned in heavy sugar syrup or used as dish decorations but also for its nutritional value i.e., it contains *β*-carotene (pro-vitamin A), phosphorus, iron, potassium, zinc, calcium, fatty acids (linoleic, oleic, palmitic and stearic acids), vitamin C (ascorbic acid) and polyphenols. The latter confer antioxidant activity (Puente *et al*., 2011).

Cape gooseberry(*Physalis peruviana,* L.) is a non-traditional horticultural crop in Egypt, it is widely used in folk medicine as a diuretic, for treating diseases such as malaria, asthma, hepatitis, dermatitis and rheumatism(Wu *et al*., 2005), and it has very positive effects for human health, highlighting medicinal properties as an antispasmodic, antiseptic, sedative, analgesic, in addition, it helps to strengthen the optic nerve, relieves throat problems and eliminates intestinal parasites and amoebas (Puente *et al*., 2011). Further, it secretes the bile juice and activates the liver function (Stary, 1983). Also, it shows antibiotic activity (Perry & Metzger, 1980). The high *β*-carotene content of cape gooseberry has the potential of having anti-carcinogenic and antioxidant effects (Steinmetz and potter 1996). Nowadays, it is used in homeopathy for the same purpose. Nutritional considerations and health benefits bring the cape gooseberry to the forefront. Therefore, in Egypt, a great attention is directed for promoting this promising crop to meet the progressive demand of local fresh markets, medicinal purposes, developing processing industry and rapid growing of exportation (Mustafa, 2009).

Despite the healthy benefits of this fruit, Egypt still cultivated this fruit in a limited area compared to other common fruits. In addition, no attention has been paid to utilize the fruits of this plant in food industries. Thus, this work aimed to prepare and evaluate a new processed and non-traditional product (which was not processed before from this fruit) such as nectar, syrup, canned whole fruits in light syrup, jam, paste, dehydrated fruits and some kinds of appetizers. Consequently these new processed products could extend the marketing season for cape gooseberry all over the year, for the public consumers and also create opportunities to export those products to other countries.

MATERIALS AND METHODS

Materials:

Cape gooseberry (*Physalis peruviana,* L) was purchased from the culture near Alexandria Governorate, Egypt. The general appearance of the whole fruit and berries of cape gooseberry fruit are illustrated in Fig. (1). Food ingredients including sugar, salt, vinegar, sunflower oil, cloves, chili, cinnamon, curcumins, garlic and onion powder, black seed, fresh pepper, fresh onion, fresh garlic, olive pickles were purchased from Alexandria market, Egypt. Pectin, carboxymethyl cellulose, xanthan gum, sodium benzoate, potassium sorbate, all chemicals and reagents used in the present study were purchased from El-Gomhouria Co., for Chemical and Medical Requisites, Alexandria, Egypt. Sodium metabisulphite and sodium chloride were obtained from El-Nasr Company. Glass jars and bottles were obtained from Edfina Company for Preserved Foods, Alexandria governorate, Egypt.

Fig. 1. General appearance of whole and berries cape gooseberry

Methods

Physical methods

Shape, skin colour, pulp colour, taste and texture of cape gooseberry fruits were visually described. Number of fruits/ kg, average fruit weight (g/fruit) and average fruit volume (cm^3/fruit) were determined as mentioned by Kramer & Twigg (1970). Sizes of fruits were measured using vernier calipers (Kanon Instruments, Japan) with an accuracy of 0.1 mm. The density was calculated as mass/volume of a fruit (Khurmi, 1982). In addition, husk, yield after dehusking, juice, seeds and skin of cape gooseberry fruits were weighed by a top loading balance (model: D0001-HR120, AQD company, Limited EC).

Colour of cape gooseberry fruit sample was observed visually and measured with a Hunter Lab Colourimeter (Ultra scan vis, USA) as outlined by Piggott (1984). The pH value was determined using glass electrode pH meter (Persica model pH 900, Switzerland) as described in the AOAC (2003). The content of total soluble solids (TSS) at ambient temp expressed as ^{o}Brix was determined using a digital

refractometer (Hanna, HI 96811, Germany) as described in the AOAC (2003). Viscosity of the pulp and juice of cape gooseberry was determined by using a Brookfield Viscometer (model DV-II + Pro, Brookfield Engineering Laboratories, Middleboro, MA, USA) at 24.8°C with spindle number SC3- 15after 30s rotation of 5 rpm (Swami *et al*., 2013)

Chemical Methods

Proximate chemical composition

Moisture, crude protein, crude ether extract, crude fiber, ash and total, reducing and non-reducing sugars were determined according to the AOAC (2003) unless otherwise stated. Nitrogen free extract was calculated by difference. Titratable acidity as % citric acid was determined according to AOAC (2003). Energy value was calculated using the universally acceptable conversion factors by multiplying protein and carbohydrates by 4.00 and fat by 9.00 Kcal/g.

Mineral composition

Minerals including K, Mg, Fe, Mn and Zn were determined according to the method described in AOAC (2000) method.

Bioactive Compounds

Determination of ascorbic acid

Ascorbic acid was determined using 2,6-dichloroindophenol by the AOAC (2003)

Determination of ß-carotene

The total carotenoids content was determined in the acetone extract and measured spectrophotometrically at 440 nm as (mg/g) by the AOAC (2003).

Determination of A, B and total chlorophyll

Chlorophyll (a, b and total) were determined from fresh tissues of the cape gooseberry according to the method described by Moran & Porath (1980) using N,N-dimethyl formamide (DMF).

Determination of total phenols, flavonoid content and antioxidant activity

One g sample was mixed with 10 ml of 80 % methanol and stirred at room temperature for 24 h and filtered. Total phenols, flavonoid content and antioxidant activity were determined in the methanolic extract.

The total phenolic content as (mg gallic acid /100g) was determined by Folin-Ciocalteu reagent after extracting with 80% methanol according to the method of Maurya & Singh (2010). Total flavonoid content as (mg rutin /100g) was determined according to the method of Zarina & Tan (2013).

Antioxidant activity of the samples after extracting with 80% methanol was determined by scavenging the radicals with 2,2-diphenyl-1-picrylhydrazyl- hydrate

(DPPH) as described by Brand Williams *et al*., (1995) and expressed as percentage inhibition of the DPPH radical.

Technological methods

Cape gooseberry samples were manually dehusked , sorted to select the ripe and intact fruits and graded up to their colour, then washed with tap water and drained. dehusked cape gooseberry fruits were divided into three parts and the process was completed as follows

Part one (1): Whole fruits were used for processing dehydrated and canned compote fruits

Part two (2): Fruits were pulped using a fruit pulper (Kenwood major titanium, Japan) and the pulp was used to prepare jam, syrup and appetizers A, B. The pulp obtained was stored at -18^{o}C until used.

Part three (3): The extracted pulp was filtrated through a cheese cloth to separate the seeds and skins then it was used for the processing of nectar, paste. The fruit juice was stored at -18^{o}C until used.

Table (1) shows the Proportions of the different ingredients used for preparing compote, dehydrated fruits, nectar, paste, syrup, jam and appetizer (A, B) according to the recipes recommended by Edfina Company for Preserved Foods, Alexandria, Egypt. Meanwhile, Fig (2) illustrates the flow sheet of processing such products. All products in this study were manufactured in Edfina Company for Preserved Food, Alexandria, Egypt.

Sensory evaluation

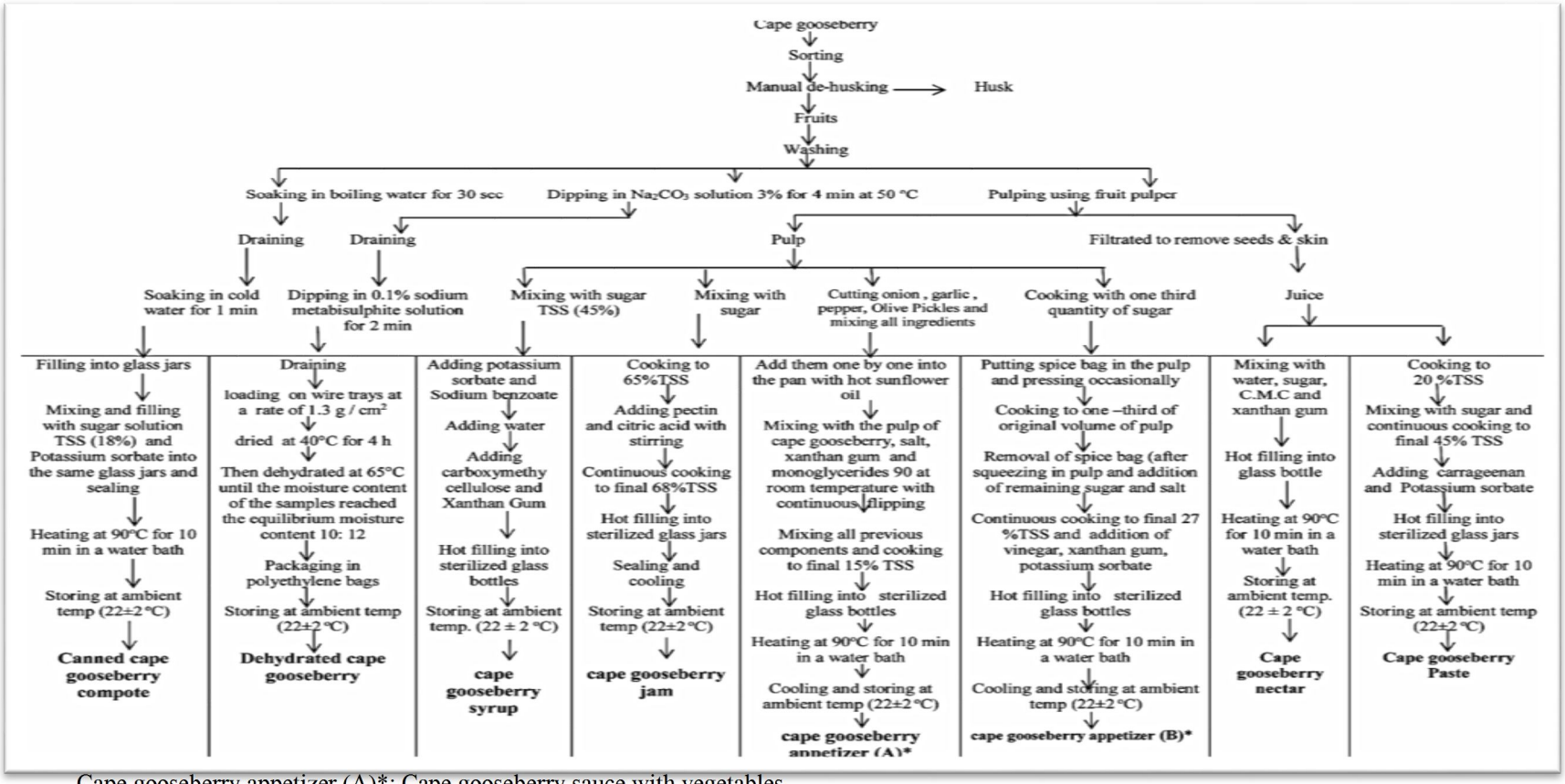
Colour, odour, taste, texture and overall palatability of the products were assessed using 10 panelists from the Food Technol. Lab., Food Technol. Research Inst., Agriculture Research Center, of Sabahia, Alexandria, Egypt. The panelists were asked to score the above attributes according to a standard hedonic rating scale from 9 (like extremely) to 1 (dislike extremely) according to (Walts *et al*., 1989).

Table 1. Proportions of the different ingredients used in preparing some cape gooseberry products

Ingredient (g)	Cape gooseberry products							
	Whole		Juice		Pulp			
	Compote	Dehydrated fruits	Nectar	Paste	Syrup	Jam	Appetizer (A)*	Appetizer (B)**
Whole cape gooseberry	240	1000	-	-	-	-	-	-
Cape gooseberry pulp	-	-	-	-	450	350	652	780
Cape gooseberry Juice	-	-	200	-	-	-	-	-
Cape gooseberry Juice (20 %)	-	-	-	750	-	-	-	-
Sugar	180	-	125	300	410	642	-	125
C.M.C	-	-	2	-	2	-	-	-
Xanthan gum	-	-	1	-	1	-	1	2.5
Carrageenan	-	-	-	4.5	-	-	-	-
Pectin	-	-	-	-	-	5.5	-	-
Citric acid	-	-	-	-	-	2.5	-	-
Sodium benzoate	-	-	-	-	0.4	-	-	-
Potassium sorbate	0.5	-	-	0.37	0.6	-	-	0.5
Water	579.5	-	672	-	136	-	-	-
Salt	-	-	-	-	-	-	5	20
Natural vingar (5%)	-	-	-	-	-	-	-	60
Sunflower oil	-	-	-	-	-	-	100	-
Cloves powder	-	-	-	-	-	-	-	2.5
Cinnamon powder	-	-	-	-	-	-	-	4
Curcumins powder	-	-	-	-	-	-	1.5	-
Onion powder	-	-	-	-	-	-	-	3
Garlic powder	-	-	-	-	-	-	-	2.5
Fresh cut pepper	-	-	-	-	-	-	80	-
Fresh cut onion	-	-	-	-	-	-	80	-
Fresh cut garlic	-	-	-	-	-	-	30	-
Olive Pickles	-	-	-	-	-	-	50	-
Monoglycerides 90		-	-		-	-	0.5	-
Sodium carbonate (%)		3						
sodium metabisulphite (%)		0.1						

Appetizer (A)*: Cape gooseberry sauce with vegetables

Appetizer (B)**: Cape gooseberry sauce with ketchup spices



Cape gooseberry appetizer (A)*: Cape gooseberry sauce with vegetables

Cape gooseberry appetizer (B)**: Cape gooseberry sauce with ketchup spice

Fig. 2. Flow sheet for preparing non-traditional cape gooseberry products

RESULTS AND DISCUSSION

Fruit properties

As shown in Table (2), the shape of the fresh cape gooseberry fruit was berry (small round).Skin and pulp colour were orange- yellow greenish colour. Fruit taste was light sweet and acidic. The parts used of cape gooseberry fruit were whole fruit without husk (pulp, seeds and skin) and the fruit texture was smooth and waxy**.**

Table 2. Appearance, physical and technological properties of fresh cape gooseberry

Properties	Description
1- Appearance properties*	
Shape	Berry (small round)
Skin colour	Orange- yellow greenish
Pulp colour	Orange -yellow greenish
Taste	light sweet and acidic taste
Fruit texture	Smooth and waxy
Parts used	Whole fruit without husk (pulp, seeds and skin)
	Value
2- physical properties*	
Number of fruit / kg	213.33±0.58
Average fruit weight (g/fruit)	4.69±0.73
Average fruit volume (cm^3/fruit)	4.28±0.95
Average diameter (cm)	1.95±0.064
Fruit density (g/cm^3)	1.10± 0.84
4- Technological properties **	
Husk (%)	
Pulp yield after dehusking (%)	8.02±0.68
Extracted Juice (%)	91.98±0.68
Seeds and skin (%)	79±1.0
Extracted juice / seeds and skin ratio	21±1.0
	3.76 ±0.23

*Results are mean value of 10 determination ±standard deviation.

** Results are mean value of 3 determination ±standard deviation

The data in Table (2) reveal that the number of fruits/kg, average fruit weight , volume and diameter were 213.33 fruit/kg, 4.69 g/fruit , 4.28 cm3/fruit and 1.95 cm, respectively. The percentage of husk was 8.02 % and pulp yield after dehusking was 91.98 %. The extracted juice represents 79% while the seeds and skins together amount were 21% of the whole fruit., the juice/seeds and skins ratio was relatively high (3.76).The obtained results are not in accordance with those reported by Abou-Gharbia & Abou-Tour (2001), Bakry (2003) and Abou-Farrag *et al*. (2013) which may be due to species, environmental and agricultural conditions as well as time of harvesting. The obtained result indicated that the fruit density (g/cm^3) was 1.10, El Sheikha *et al*. (2008) found a similar result for the variety *Physalis pubescens* in which the fruits density was 1.10 (g/cm^3).

Physical and chemical properties of fresh cape gooseberry

Physical and chemical properties of cape gooseberry are shown in Table (3). Total solids (TS), total soluble solids (TSS) and pH values of cape gooseberry fruit were 15.86%, 13.75 ^{o}Brix and 3.7, respectively. The percentage of TSS and pH values were close to that reported by Abou-Gharbia & Abou-Tour (2001) and El Sheikha *et al*. (2008) and were higher than that presented by Abou-Farrag *et al*. (2013). The difference between total solids and total soluble solids is mainly due to the insoluble pectin and fibers.

Table (3) also shows the values for chromaticity coordinates: the cartesian coordinates (L*, a* and b*). The coordinate L* corresponds to a value of 50.39 and allows to conclude that the berries are clear, because the value is closer to 100 (white) than to 0 (black).Comparing with the results obtained by Solange *et al*. (2015), it was found that the berries in the present work are slightly clearer than those analyzed by the authors, (L* value of 65.72). The coordinate a* was found to be 16.69. This coordinate correspond to red colour when positive, as in the present case, and the redness is more intense as the value increases. In accordance with the results obtained in the present study the coordinate a* was found to be 16.69 in Solange *et al*. (2015) study. Hence, the berries evaluated in this work have a slightly more intense red colouration. The value of the coordinate b* is 39.66, and because it is positive lies within the colour spectrum of yellow. Comparing with the results of Solange *et al*. (2015), who reported values for this coordinate being 58.11, the slight differences found in the colour coordinates may naturally occur due to different maturity stages, cultivar or cultivation procedures. Also, as shown in Table (3), the viscosity of cape gooseberry fruit pulp and juice were 3300 and 600 cp. The difference between these values is due to the pulp that contains peels and seeds, while the juice that is free of them.

Table 3. Physicochemical properties of fresh cape gooseberry (fresh weight basis)

Properties	Value
Total solids * (TS) %	15.86±0.67
Total soluble solids * (TSS) ^{o}Brix	13.75±0.96
PH*	3.7±0.10
Hunter Lab measurements	
L	50.39
a	17.80
b	39.66
Viscosity of pulp	3300 cP
Viscosity of juice	600 cP

*Means of three replicates ± S.D

cP: centipoise

Chemical composition and mineral contents of fresh cape gooseberry

The proximate chemical composition of fresh cape gooseberry on both fresh and dry weight basis are shown in Table (4). It could be noticed that the moisture content in cape gooseberry was 84.14%, this value was higher than 80.7% and 81.49 reported by Abou-Gharbia & Abou- Tour (2001) and Abou-Farrag *et al*. (2013) for *P. pruinosa* fruits . Also it can be noted that the crude protein (10.21%) was lower than that reported by Abou-Farrag *et al.* (2013) (12.75%) for *P. pruinosa* fruits and El Sheikha (2008) (13.18%) for *Physalis pubescens*. Crude ether extract of fresh cape gooseberry was 7.39% on dry weight basis. This value disagreed with the value reported by Abou-Gharbia & Abou-Tour (2001) and Abou-Farrag *et al*. (2013). They reported that crude ether extract was 5.70% and 4.96% (on dry weight basis). On the other hand, the obtained value was higher than that reported by Bakry (2003), who found that the crude ether extract content of cape gooseberry was 0.44% on dry weight basis. Total ash content of cape gooseberry was 7.97% on dry weight basis. This value was higher than that presented by Abou-Gharbia & Abou-Tour (2001) (5.70%) and Abou-Farrag *et al*. (2013) (5.98%). On the other hand, crude fiber of cape gooseberry was 16.36% on dry weight basis. This value was lower than that reported by Bakry (2003) and Abou-Farrag *et al*. (2013).

The results of nitrogen free extract (58.07%) were close to that reported by Abou-Farrag *et al.* (2013) (56.93%). Moreover, the sugars (total, reducing and non-reducing) were 56.24, 26.51 and 29.78% on dry weight basis, respectively. Although, the total sugars were very close to that found by Bakry (2003) (54.22%) and Abou-Farrag *et al*. (2013) (54.22%). Reducing sugars were higher than that reported by Abou-Gharbia & Abou-Tour (2001) and Bakry (2003). The obtained results indicated that non-reducing sugars represented about 52.95% of the total sugars. These results agreed with those reported by Abou-Farrag *et al*. (2013). The energy value was 53.86 and 339.63 expressed as Kcal/ 100g sample on fresh and dry weight basis respectively. This result was lower than that found by Rodrigues *et al*. (2009) (88.72 Kcal/ 100g sample on fresh weight basis)

Total titratable acidity (TA) of fruits was 1.20% on fresh weight basis. This TA value is similar to that reported by Abou-Gharbia & Abou- Tour (2001) for *P. pruinosa* as well as El Sheikha *et al*. (2008) for *p. pubescens* the same species.

Mineral contents of fresh cape gooseberry that included K, Mg, Mn, Fe, and Zn were 4346, 411.9, 1.24, 21.48 and 22.06 ppm (on dry weight basis), respectively. These values were higher than that reported by Bakry (2003) and Abou-Farrag *et al.* (2013).

Table 4. Chemical composition and mineral contents of fresh cape gooseberry (fresh and dry weight basis)

Component	Value*	
	fresh weight basis (%)	dry weight basis (%)
Moisture	84.14±0.67	———
Crude protein	1.62±0.17	10.21±0.17
Crude ether extract	1.17±0.34	7.39±0.34
Total Ash	1.26±0.188	7.97±0.188
Crude fiber	2.60±0.10	16.36±0.10
Nitrogen free extract **	9.21±0.34	58.07±0.34
Total sugars	8.92±1.52	56.24±1.52
Reducing sugars	4.20±1.34	26.51±1.34
Non reducing sugars	4.72±1.45	29.78±1.45
Titratable acidity***	1.20±0.06	———
Energy value (Kcal /100g)	53.86±0.28	339.63±0.28
Minerals (ppm)		
K	689.28	4346
Mg	65.33	411.9
Mn	0.20	1.24
Fe	3.41	21.48
Zn	3.50	22.06

*Mean of three replicates ± SD ** Calculated by difference

***Titratable acidity as % citric acid

Bioactive compounds of fresh cape gooseberry

The total phenolic content, total flavonoids, antioxidant activity, ascorbic acid, *ß*-carotene, total chlorophyll, chlorophyll A and B of cape gooseberry are shown in Table (5). The results showed that cape gooseberry had high amounts of phenolic content being 669.80 mg GAE /100g dry basis. These results are higher than the results reported by Jéssica *et al*. (2013) (321.05 mg GAE /100g dry basis) and lower than the results reported by Nazmi *et al*. (2014) (834.863 mg GAE /100 g dry basis)

It could be also observed that cape gooseberry had considerable amount of flavonoid content being 78.07 mg /100g dry basis. However, the total flavonoids are found to be lower than those reported by Jéssica *et al*. (2013) who mentioned that the total flavonoid content in cape gooseberry was 99.25 mg/100g dry basis

The antioxidant activity of the methanolic extract of fresh cape gooseberry was 76.83% as shown in Table (5). This result is in accordance with that found by Ramadan & Mörsel (2007) who reported that the antioxidant activity in fresh cape gooseberry was78% on fresh weight. Jéssica *et al*. (2013) mentioned that antioxidant capacity may be related to the amount of vitamin C, *ß* -carotene, total phenolic and flavonoid content since these compounds act as scavengers of the free radicals produced during oxidation reactions.

Fresh cape gooseberry contained a moderate amount of ascorbic acid (40.13 mg/100 g) on fresh weight basis, which was very close to that found by Abou-Gharbia & Abou- Tour (2001) (39.50 mg/100g) and El Sheikha *et al*. (2008) (39.68 mg/100g) and lower than that reported by Ramadan & Mörsel (2003) (43 mg/100) while it was higher than that reported by Ozturk *et al*. (2017) who found that ascorbic acid content of golden berry samples have showed varied between 31.40-35.10mg/100g.

Table 5. Bioactive compounds of fresh cape gooseberry

Component	**Value***	
	fresh weight basis	**(dry weight basis)**
Total phenolic content (mg/100g) **	106.38 ± 0.45	669.80 ± 2.87
Total flavonoids (mg/100g) ***	12.38 ± 0.67	78.07±4.16
Antioxidant activity (%)	76.83±1.38	----
Ascorbic acid (mg/100g)	40.13 ±1.57	253.03± 9.93
β-carotene (mg/g)	12.80 ±1.15	80.71±7.28
chlorophyll A (µg/g)	2.47±0.28	15.56 ± 1.77
chlorophyll B (µg/g)	3.64±0.17	22.96±1.09
Total chlorophyll (µg/g)	6.11± 0.45	38.52±2.84

* Mean of three replicates ± SD ** Gallic acid equivalent *** *Rutin equivalent*

High amounts of *β*-carotene were detected also in the cape gooseberry (Table 5). The *β*-carotene content of fresh cape gooseberry was (12.8 mg/g) on fresh weight basis. This value was higher than that previously reported by Vilbett *et al*. (2013) (10.75 mg/g) and Ramadan & Mörsel (2007) (4.32 mg/ g) and lower than that reported by Puente *et al.* (2011) (14.60 mg/100 g). Therefore, cape gooseberry could be a novel source for nutraceuticals or bioactive components of natural origin that can be utilised in food processing as natural additives and obviate the need for artificial additives.

Cape gooseberry contained low amounts of A, B and total chlorophyll (2.47, 3.64 and 6.11 µg/g sample), respectively (Table 5) which was lower than that mentioned by Abou-Gharbia & Abou- Tour (2001) who found that the amount of total chlorophyll was 18.50 µg/g sample.

Total soluble solids, pH, total acidity and salt contents of processed cape gooseberry products

Table (6) shows the TSS, pH, total acidity and salt contents in different processed products of cape gooseberry. The results showed that cape gooseberry jam had the highest total soluble solids (68 ^{o}Brix) followed by Paste and Syrup (45.11, 45.04 ^{o}Brix), respectively, while canned compote and appetizer (A) had the lowest total soluble solids (15.11, 15.14 ^{o}Brix), respectively. Addition of sugar was responsible for the increased value of TSS. According to the data in Table (6), the pH value in

different products ranged between 3.40 in canned compote to 2.93 in jam and appetizer (B) products. Also the data in Table (6) revealed that the processed dehydrated cape gooseberry had the highest total acidity (5.32). This result was mainly due to the loss of moisture content during the dehydration process. The lowest total acidity was observed in nectar product. Appetizer (A) and (B) contained 2.5 and 3.1 salts, respectively, which is mainly due to addition of salt during the processing of these products. In general, these results depended on the type and method of processing of these products

Table 6. Total soluble solids, pH, total acidity and salt of processed cape gooseberry products.

Cape gooseberry products	Properties ***			
	TSS (°Brix)	pH	Total acidity (%)	Salt
Canned compote	15.11±0.11	3.40 ± 0.03	0.89±0.00	-
Dehydrated fruits	-	3.10±0.03	5.32±0.11	-
Nectar	16.03 ± 0.05	3.63 ± 0.02	0.26 ± 0.01	-
Syrup	45.04 ± 0.07	3.18±0.60	0.86±0.01	-
Paste	45.11± 0.10	3.40±0.02	1.40±0.25	-
Jam	68 ± 0.00	2.93± 0.03	0.60±0.01	-
Appetizer (A)*	15.14 ± 0.12	3.33 ± 0.03	1.17±0.10	2.5 ±0.10
Appetizer (B)**	27.11±0.12	2.93 ± 0.03	1.2±1.40	3.1 ±0.15

Appetizer (A)*: Cape gooseberry sauce with vegetables

Appetizer (B)**: Cape gooseberry sauce with ketchup spices

*** Mean of three replicates ± SD on fresh weight basis

Some bioactive compounds of processed cape gooseberry products.

Table (7) shows some bioactive compounds including total polyphenols, total flavonoids, antioxidant activity and *β*-carotene of processed cape gooseberry products.

The highest amount of polyphenols (on fresh weight basis) was found in dehydrated cape gooseberry product (238.99 mg/100g) followed by appetizer B (133.61mg/100) and appetizer A (125.55mg/100g) while the lowest amount was recorded in jam and nectar being 40.80 and 20.46 mg/100g, respectively. The syrup, paste and canned compote products contained 43, 70.52 and 94.08 mg/100 g, respectively.

Also, the data in Table (7) showed that total flavonoid content of different processed cape gooseberries products was highest amount 54.16 mg/100g in dehydrated fruit and 3.38 mg/100g in nectar product (lowest amount. The appetizer (B), (A) and canned compote products contained high amounts of total flavonoids which recorded 21.99, 18.35 and 11.98mg/100g, respectively. On the other hand, the paste, syrup and jam products contained low amounts of total flavonoids which recorded 7.55, 5.28 and 4.26 mg/100g, respectively.

Table 7. Some bioactive compounds of processed cape gooseberry products.

Cape gooseberry products	Bioactive compounds***			
	**** Total phenolic content mg/100g	***** Total flavonoids mg/100g	antioxidant activity (%)	β-carotene mg/g
Canned compote	94.08±3.07	11.98±0.54	65..43±1.05	12.34±0.53
Dehydrated fruit	238.99±4.18	54.16±0.57	83.55±2.55	22.53±0.34
Nectar	20.46 ±2.43	3.38 ± 0.59	19.63±2.31	4.44 ± 0.74
Syrup	43.00± 1.67	5.28±0.58	32.25±2.11	6.44±0.48
Paste	70.52 ± 1.35	7.55±0.54	46.65±1.65	11.90±0.56
Jam	40.80 ± 2.7	4.26 ±0.36	24.76±1.22	3.11±0.87
Appetizer (A)*	125.55±1.16	18.35±0.23	78.34±2.11	17.19±0.18
Appetizer (B)**	133.61 ± 1.02	21.99±2.24	80.21±1.45	13.89±0.89

Appetizer (A)*: Cape gooseberry sauce with vegetables.
Appetizer (B) **: Cape gooseberry sauce with ketchup spices .
***Mean of three replicates ± SD on fresh weight basis.
**** Gallic acid equivalent ***** *Rutin equivalent*

Antioxidant activity of processed cape gooseberry products varied between 19.63 –83.55%(Table 7).These results depended on type, ingredients and method of processing of deferent products. Some of the medicinal properties of the fruit of *P. peruviana* L. are associated with the fruit's antioxidant capacity (Puente *et al.,* ˜·ıı.

According to the data in Table (7), *β*-carotene content in different cape gooseberry products showed high amounts in dehydrated fruit appetizer **(A**) , appetizer **(B**) canned compote and paste recording 22.53, 17.19, 13.89,12.34 and 11.90 mg/g , respectively while syrup, nectar and jam contained low amounts recording 6.44, 4.44 and 3.11 mg/g, respectively. *B*-carotene is very important in the prevention of certain human diseases such as cancer. The reason that carotenoids prevent cancer is related to the antioxidant activity that deactivates free radicals generated in tissues (Castro *et al.*, 2008).

In general, the highest amount of total polyphenols, flavonoids (as mg/100g), antioxidant activity (%) and *β*-carotene as (mg/g) in appetizer (A) and (B) may be related to the food ingredients used for their preparation: vegetables, herbs and spices

Sensory evaluation of processed cape gooseberry products.

Table (8) summarizes the sensory evaluation including colour, taste, odour, texture, appearance and overall acceptability of eight processed cape gooseberry products. Generally, all the products were accepted by the panelists. The description of the overall acceptability by the panelists was extremely acceptable. Fig (3) illustrates the products manufactured from the cape gooseberry fruits.

Table 8. Sensory evaluation of processed cape gooseberry products

Cape gooseberry Products	Colour	Taste	Odour	Texture	Appearance	Overall acceptability
Canned compote	8.88±0.33	8.11±1.05	8.0±0.87	8.44±0.53	8.89±0.33	8.46±0.35
Dehydrated	8.22±0.66	7.78±0.97	7.78±0.67	7.67±0.71	8.11±0.33	7.91±0.40
Nectar	8.55±0.53	8.44±0.53	8.33±0.70	8.44±0.53	8.66±0.50	8.49±0.25
Syrup	8.77±0.44	8.33±1.00	8.22±0.83	8.11±0.60	8.66±0.50	8.42±0.52
Paste	8.00±0.70	7.78±0.83	8.44±0.73	8.33±0.5	7.88±0.78	8.09±0.55
Jam	8.67±0.50	9.00±0.00	8.77±0.44	9.00±0.0	8.78±0.444	8.84±0.19
Appetizer (A)*	8.00±0.71	8.11±1.17	8.11±0.78	8.66±0.5	8.33±0.71	8.24±0.60
Appetizer (B)**	8.22±0.83	8.22±0.83	8.44±0.73	8.33±0.71	8.22±0.67	8.29±0.66

Appetizer (A)*: Cape gooseberry sauce with vegetables

Appetizer (B)**: Cape gooseberry sauce with ketchup spices

CONCLUSION

Cape gooseberry fruit could be considered a suitable plant for different food applications. In the present study, useful information about the industrial application of cape gooseberry in the production of canned compote, dehydrated fruit, nectar, syrup, paste, jam, appetizer (A) and (B) are provided. All products were highly accepted by the panelist's importance who gave high scores to the products. This will be interesting as an indication of the potentially nutraceutical of cape gooseberry as a rich source of bioactive phytochemicals and functional foods. Cape gooseberry can be a very interesting candidate for the processing of new functional foods and drinks.

Fig. 3. Cape gooseberry products

*Appetizer A: Cape gooseberry sauce with vegetables

** Appetizer B : Cape gooseberry sauce with ketchup spices

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تقييم منتجات جديدة غير تقليدية مصنعة من الحرنكش

رضا عبد الحكيم عامر

قسم بحوث تصنيع الحاصلات البستانية – معهد بحوث تكنولوجيا الاغذية – مركز البحوث الزراعية – مصر

تعتبر ثمار (*Physalis peruviana* , L) cape gooseberry من المحاصيل البستانية الواعدة والمعروفة فى مصر بإسم الحرنكش والتى إكتسبت شعبية فى الأسواق المتخصصة. إلا إنها تستخدم فى مصر كغذاء للتسالى فقط لذا تهدف هذه الدراسة إلى الاستفادة من هذه الثمار فى إنتاج منتجات جديدة مثل الكمبوت ،الحرنكش المجفف، النيكتار ، الشراب المركز ، عجينه الفواكهه، المربى ، فاتحات الشهية . تم دراسة كل من الخواص الفيزيائية ، الكيميائية ، التكنولوجية لثمار الحرنكش . ولقد وجد اللب حلو الطعم (المواد الصلبة الذائبة 13,75) ذو طبيعة حامضبة (قيمة الاس الهيدروجينى 3,7 والحموضة التنقيطية 1,20 % كحامض سيتريك) ، وتمثل السكريات غير المختزلة 52,95 من السكريات الكلية 56,24 . كما أظهرت النتائج ايضا أن ثمار الحرنكش تعتبر مصدراً جيدا للبيتا كاروتين و فيتامين ج والمركبات الفينولية و الفلافونويدات ومضادات الاكسدة بالاضافة الى بعض المعادن مثل البوتاسيوم والماغنيسيوم والحديد والزنك . ونتيجة لذلك تم استخدام ثمار الحرنكش فى تحضير بعض الاغذية الوظيفية والتى أظهرت الخواص الحسية لكل منها قبولا عالياً لدى المحكمين .