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Some physico-chemical and microbiologic properties of brine and fermented Physalis (*Physalis peruvianaL.*) fruits

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Abstract

The acidity values were determined as 0.47% in brine and 1.11 % in products with vinegar. Radical activity values of Physalis with brine, vinegar and raw changed between 0.754 (brine) to 4.30 (%) (raw material). In addition, total phenol contents of samples ranged from 0.473 mg GAE/100 ml to 4.30 mgGAE/100 ml. The oil contents of physalis fruits of raw, salted and fermented product in vinegar were found to be 2.25%, 1.03% and 1.17%, respectively. The microbiological analysis were carried out at the end of fermentation, and the total number of bacteria in birine was found to be eight times more than those of the products with vinegar. The oleic acid contents changed between 50.01% and 50.68%. The highest element had potassium, by followed by P, Mg and Ca in descending order. Physalis are nutritionally an important and exotic fruit.

Keywords: *Physalis*, fermentation, proximate analyses, fatty acid, total phenol, antioxidant activity, minerals

1. Introduction

Physalis is an exotic fruit that belong to the Solanaceae family. It is included in the priority list of many goverments`horticulture and fruit export plans [1]. *Physalis peruviana* known as cape gooseberry, Inca berry, golden berry, ras bhari, uvilla and uchuva was culticated in the most region of world (South America, South Africa) during the 19th century. It is related to a large number of edible plants, including tomato, eggplant and potato, but not to the cherry, ribes gooseberry, Indian gooseberry or Chinese gooseberry [2]. The crude extract of the fruit-bearing plant has demonstrated antihepatoma and anti-inflammatory activities [3,4].

In folk medicine, *Physalis peruviana* has been used as a medicinal herb to treat cancer, leukemia, malaria, asthma, hepatitis, dermatitis and rheumatism [4,5]. In most countries, the golden berry is cultivated in backyards for direct consuming. However, they do carry prestige in some international markets, such Europe, where premium prices are paid for the fruits. Besides having a future potential as fresh fruit, it can be enjoyed as an ingredient in salads, cooked dishes, desserts, jams, natural snacks, and fruit preserves [6,7].

Pickling foods is a well-established food processing technology [8]. Indeed, phenols are a major group of antioxidant phytochemicals which can play an important role in adsorbing and neutralizing free

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radicals [9]. The aim of current study was to determine some physico-chemical (proximate analysis, antioxidant activity, total phenol, fatty acid composition, mineral contents) and microbiological properties of fermented Physalis (*Physalis peruviana*) fruits.

2. Materials and Method

Material. Fruits of cape gooseberry were collected from the experimental greenhouse of the Selcuk University Çumra Vocational High School. Fruits were brought into laboratuary under cold bag within the shortest time. Raw and processed caper fruits which were removed from foreign materials and dehydrated in drying oven (45 ^{o}C) were ground as to pass from 0.5 mm diameter sifter. The ground samples were preserved in clean, dry, non air-permeable and colourful glass jars during analysis. The salt used in brine is iodine-free rock salt. The vinegar of grapes with 4% acid was used as vinegar.

Method. The chemical analysis carried out on the product and the brine were determined according to AOAC [10]. Physical and chemical properties of raw fruits were detected before processing. The countings of total bacteria, coliform bacteria and lactic acid bacteria were determined according to Özcan [11]. Physalis fruits (yellowish-green) were put into 1 L jars and brined at a pack-out ratio of 2/1 (brine/fruits). Another group was prepared with full vinegar (4% acidity). All the samples were subject to fermentation at room temperature for 20 days. After five days, the salt concentration of each jar was increased regularly to maintain the original level. So, the last concentration level of each brine was reached in certain intervals on 10 days. Brine analyses was carried out at the last day of fermentation.

Phsico-chemical and microbilogical analyses. Some phsico-chemical and microbilogical analyses were undertaken at the end of fermentation. Dry matter was determined at 105±2 ^{o}C in oven. The pH was determined with a pH meter. Titratable acidity was determined according to Paulauskiene et al. [12] with 0.1 N NaOH in the brine (5 ml) with phenolphthalein as an indicator. The results were calculated as lactic acid (w/v) of brine. Percentage salt analyses were determined according to Association of Official Analytical Chemists [10]. Rogosa Agar (Merck, Darmstadt, Germany), Plate Count Agar (Oxoid, England) and Eosin Methylen Blue Agar (Oxoid, England) were used for lactic acid bacteria, total bacteria and coliforms in the microbiological analyses, respectively. Dilutions were prepared (x10^{-4}) and colonies were measured as colony forming units/ml [13].

Oil content. About 5 g of the ground materials was extracted with petroleum ether in a Soxhlet apparatus for 6h. The solvent was concentrated on a rotary evaporator under reduced pressure at 60 ^{o}C. The oil was dried by a stream of nitrogen and stored at -20 ^{o}C until use.

The total phenolic contents. The total phenolic contents of Physalis were measured using the Folin-Ciocalteu`s colorimetric method [14]. In reaction mixture, methanolic solution. Extract, distilled water, sodium carbonate and Folin-Ciocalteu reagent were mixtured. The absorbance of the resulting blue-coloured solution was measured at 765 nm after incubation at 35 ^{o}C for 1.5 h with intermittent shaking. The total phenolic content was expressed as gallic acid equivalents (GAE) in mg per g of dry material.

Radical Scavenging Assay. Free radical scavenging activity of the sample extract was determined according to the method of Lee et al. [15]. This method depends on the measurement of the reducing ability of antioxidants toward the 1,1-diphenyl-2-picrylhydrazyl (DPPH). The solution of the extract (1 ml) was mixed with 2 ml of 10 mg/L methanolic solution DPPH. The mixture was shaken vigorously and absorbance was recorded at 517 nm by using spectrophotometer. A mixture of 100 µl of methanol and 10 ml of DPPH solution was used as the control.

Determination of fatty acids. Fatty acid compositions for Physalis fruit oil were determined using a modified fatty acid methyl ester method as described by Hışıl [16]. The oil was extracted three times for 2 g air-dried seed sample by homogenization with petroleum ether. The oil samples (50-100 mg) was converted to its fatty acid methyl esters (FAME). The methyl esters esters of the fatty acids (1 µl) were analysed in a Gas Chromotography (Shimadzu GC-2010) equipped with a flame ionising detector (FID), a fused silica capillary column (60 m x 0.25 mm i.d.; film

thickness 0.20 micrometer). It was operated under the following conditions: oven temperature program. 90 °C for 7 min. Raised to 240 °C at a rate 5 °C/min and than kept at 240 °C for 15 min); injector and detector temperatures, 260 and 260 °C; respectively, carrier gas. nitrogen at flow rate of 1.51 ml/min; split ratio. 1/50 µl/min. Quantitative analyses of the fatty acids were performed using the heptadecanoic acid methyl ester as internal Standard. The results are mean values of three replicates.

Mineral analyses. Collected physalis samples were dried at 70 °C in a drying cabinet with air-circulation until they reached constant weight. Later, about 0.5 g dried and ground sample was digested by using 5ml of 65% HNO_3 and 2 ml of 35% H_2O_2 in a closed microwave system (Cem-MARS Xpress). The volume of the digested samples was completed to 20 ml with ultra-deionized water and mineral concentrations were determined by inductively coupled plasma-optical emission spectroscopy (ICP-OES; Vista-Pro Axial; Varian Pty Ltd, Australia) [17].

Working conditions of ICP-AES:
Instrument :ICP-AES (Varian-Vista)
RF Power :0.7-1.5 kw (1.2-1.3 kw for Axial)
Plasma gas flow rate (Ar) :10.5-15 L/min. (radial)
15 " (Axial)
Auxilary gas flow rate (Ar) :1.5"
Viewing height :5-12 mm
Copy and reading time :1-5 s (max.60 s)
Copy time:3 s (max. 100 s)

Results of the research were analysed for statistical significance by analysis of variance [18].

3.Results and discussion

The chemical properties of cape gooseberry fruits were given in Table 1. The oil contents of raw, salted and fermented fruits in vinegar were determined as 2.25%, 1.03% and 1.17%, respectively. It was designated that the contents of dry matter were found as 3.32% in salted products and 7.64% in products with vinegar. It was determined that the salt contents were close to each other in both brines and these contents were found to be 5.23% and 5.27%, respectively. Rodrigues et al. [7] reported that *Physalis* presented high contents of ash and total lipid, 0.8 and 3.16 g/100 g, respectively. The same researchers determined 80.97% moisture, 3.16% total lipids, 1.85% protein and 0.80 % ash in *Physalis peruviana* L. The the highest dry matter (16.73%) and ascorbic acid (25.66 mg/100 g) contents were determined in *Physalis peruviana* L. fruits.

The microbiological properties of the brines were given in Table 2. The microbiological analysis were carried out at the end of fermentation and the total number of bacterias in birine was found to be 8 times more than that of the products with vinegar

Table 1. Some chemical properties of brine and product

Properties	**Brine**	**Vinegar**	**Raw material**
Crude oil (%)	1.03[a]±0.62	1.17±0.54	2.25±0.33
Dry matter (%)	3.32±0.03	7.64±0.11	2.97±0.11
Salt (%)	5.23±0.07	5.27±0.13	-b
Acidity(%)	0.47±0.02	1.11±0.01	-
pH	5.46±0.01	5.94±0.01	-
RadicalScavenging Activity (%)	0.754±0.013	21.719±1.17	35.45±2.38
Total Phenol (mg GAE/100 ml)	0.473±0.028	3.66±0.21	4.30±0.32

[a]values are reported as mean±SD of three replications
[b]non-determined

Table 2. Microbiological properties of brine (cfu/ml)

Microorganisms	Brine	Vinegar
Total bacteria	56.0±3[a]	7.0±1.0
Coliforms	0.0±0.0	0.0±0.0
Lactic acid bacteria	97.0±12	104±9

[a]values are reported as mean±SD of three replications

Fatty acid composition of the cape gooseberry oil was given in Table 3. Palmitic, oleic and linoleic fatty acids were dominantly identified in the oil of cape gooseberry fruits. The highest fatty acid was found to be oleic acid, and its concentration changed between 50.01% and 50.68%. Generally, the rate of the total unsaturated fatty acids was over 75%. The fatty acids concentrations of the cape gooseberry fruit oil which fermented in brine were partly found to be higher than that of the fermented in vinegar. Ramadan and Mörsel [6] found 8.62% palmitic acid in *P. peruviana* cultivated in Germany. In addition, the fruit oil of *P. peruviana* contained 9.38 % palmitic, 2.67% stearic, 10.03% oleic, 74.42% linoleic acids [7].

The mineral contents of the cape gooseberry fruits are shown in Table 4. Mineral contents of the products varied depending on the state of the maturity of fruits, fermentation conditions and analytical conditions. In general, cape gooseberry is rich in Ca, Mg, K and P.

Table 3. Fatty acid compositions of raw and brine products (%)

Fatty acids	**Raw**	**Pickling product**	**Pickling product with vinegar**
Palmitic	11.73[a]±1.17c[b]	13.77±0.67c	12.61±0.74c
Oleic	50.01±1.58a	50.68±2.63a	50.30±3.63a
Linoleic	23.14±0.29b	26.54±1.11b	23.47±0.89b
Linolenic	5.21±0.07d	5.78±0.18d	5.36±0.09d
Arachidic	1.63±0.01e	2.80±0.09d	1.55±0.03e

[a]values are reported as mean±SD of three replications
[b]means within a column with different superscript are significantly different at $p<0.05$

Table 4. Mineral contents of raw and pickling products (mg/Kg)

Minerals	**Raw material**	**Pickling product**	**Pickling product with vinegar**
Ca	582±23[a]	1033±22	984±17
Mg	1365±14	1176±18	1191±40
K	20473±296	16698±472	17357±234
P	4110±284.8	3174±73.8	3307±211.1
Fe	40.5±2.6	34.3±0.0	50.5±1.7
Zn	15.84±0.37	16.04±0.20	17.82±0.91
Cu	8.81±0.27	8.30±0.08	10.53±0.24
Mn	8.11±0.11	6.81±0.23	6.96±0.44

[a]values are reported as mean±SD of three replications

Potassium was found as the highest element in fruits, and followed by P, Mg and Ca in descending order. Depending on the fermentation conditions, the mineral contents of the products with vinegar were partly found to be higher than those of the products in brine. This difference probably resulted from diffusion of the compounds of the products to the brine by dissolving partly. Rodrigues et al. [7] determined 1.47 g/100 g Fe, 34.70 g/100 g Mg, 9.00 g/100 g Ca, 347.0 g/100 g K and 1.10 g/100 g Na in *P.peruviana* L. So, when essential elements of *Physalis* comparing to the principal sources such as wheat germ, beans were found lower [19]. It is important to consider that the normal functioning of uman organism depends on the close regulation of potassium concentration inside and outside of the cells [20]. Manganese, an essential element in the bone development and in the metabolism of aminoacids, carbohydrates, and cholesterol [19]. Consequently, As cape gooseberry fruits are rich in unsaturated fatty acids and Ca, Mg, K and P elements, it can be considered as an important food sources in terms of human health and nutrition. *Physalis* also presents high concentration of linoleic acid. Also, sifnificant amount of several minerals such as Mg and Zn essential to human metabolism [7].

The acidity values were stated as 0.47% in brine and 1.11% in products with vinegar. The pH values of brine are close to each other and these values were

measured as 5.46 and 5.94. Radical activity values of physalis with brine, vinegar and raw changed between 0.754 (brine) and 4.30 (%) (raw material). In addition, total phenol values of samples ranged from 0.473 mg GAE/100 ml to 4.30 mg GAE/100 ml. Negative effect of the vinegar was observed on the total number of bacteria. Coliform bacteria was not detected in both products. Lactic acid bacteria developed a bit more in the products with vinegar. Lactic acid bacteria were detected as 97 cfu/ml in brine 104 cfu/ml in the products with vinegar. It was followed by linoleic acid, and this acid content was ranged from 26.54% and 23.14%. The palmitic acid content of the Physalis fruit oil was found between 11.73% and 13.77%. In general, the fatty acids concentration of the oil in non-fermented cape gooseberry fruits were partly found to be lower than that of the fermented cape gooseberry fruits. Potassium content of fruits changed between 16698 mg/Kg and 20473 mg/kg. P contents of the fruits were found between 3174 mg/kg and 4110 mg/kg. Fe and Zn contents were below 51 mg/kg. It was determined that Fe content was ranged between 34.3 mg/kg and 50.5 mg/kg and Zn content changed between 15.84 mg/kg and 17.82 mg/kg.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

References

1. El-Sheikha AF, Zaki M S, Bakr AA, El-Habashy MM, Montet D. *Physico-chemical properties and biochemical composition of Physalis (Physalis pubescens L.) fruits*. Global Science Books Ltd., UK, Food **2008**, 2(2),124-130.
2. Morton JF, Russell OS. The cape gooseberry and the Mexican husk tomato. *Florida State Hort. Soc.* 1954, *67*, 261–266.
3. Yen CY, Chiu CC, Chang FR, Chen JY, Hwang CC, Hseu YC, Yang HL, Lee AY, Tsai MT, Guo ZL, Cheng YS, Liu YC, Lan YH, Chang YC, Ko YC, Chang HW, Wu Y. Beta-Hydroxywithanolide E from *Physalis peruviana* (golden berry) inhibits growth of human lung cancer cells through DNA damage, apoptosis and G2/M arrest. *BMC Cancer*, **2010**, *10*, 46.
4. Wu SJ, Tsai JY, Chang SP, Lin DL, Wang SS, Huang SN, Ng LT. Supercritical carbon dioxide extract exhibits enhanced antioxidant and anti-inflammatory activities of *Physalis peruviana*. *Journal of Ethnopharmacology*, **2006**, *108*(3), 407–13.
5. Wu S-J, Ng L-T, Huang Y-M, Lin D-L, Wang S-S, Huang S-N, Lin C-C. Antioxidant activities of *Physalis peruviana*. *Biolog. Pharm. Bull*. **2005**, *28*, 963-966 .
6. Ramadan MF, Mörsel JT. Oil goldenberry (*Physalis peruviana* L.). *Journal of Agricultural and Food Chemistry*, **2003**, *51*, 969-974.
7. Rodrigues E, Rockenbach II, Cataneo C, Gonzaga LV, Chaves ES, Fett R. Minerals and essential fatty acids of the exotic fruit *Physalis peruviana* L.. *Cienc .Technol. Aliment.* **2009**, *29*(3), 642-645.
8. Lardos A, Kreuter MH. *Red vine leaf* (Kreuter,M.H., Head of R & D Department, eds.) Phytopharm and Phytochem. Products, Flachsmann AG, Zurich, Switzerland (2000).
9. Tlili N, Khaldi A, Triki S, Munne-Bosch. Phenolic compounds and Vitamin antioxidants of caper (*Capparis spinosa*). *Plant Foods Hum. Nutr.* **2010**, *65*, 260-265.
10. AOCS. Official Methods and recommended practices (Vol.1, 4th ed.). American Oil Chemists`Souety, Champaign, IL (1990).
11. Özcan M. Pickling and storage of caperberries (*Capparis spp*.). *Zeitschrift für Lebensmitteluntersuchung und -Forschung A*, **1999**, *75*(2), 251-256.
12. Paulauskiene A, Zebrauskiene A, Duchovskis P, Samuoliene G, Taraseviciene Z. Comparison of biological characteristics and chemical composition of *Physalis* L. Species. *Ze. Mokslai*, **2009**, *16*, 53-60.
13. Chavasit V, Hudson JA. Torries and M. A.Daeschel. Evaluation of fermentative bacteria in a model low salt cucumber juice brine. *Journal of Food Science*, **1991**, *56*, 462-465.
14. Singleton VL, Rossi JA. Colorimetry of total phenoloics with phosphomolybdic-phosphotungstic acid reagents. *American Journal of. Enology Vitis*, **1965**, *6*, 144-158.
15. Lee S K, Mbwambo Z H, Chung H S, Luyengi L, Games E J C, Mehta RG. Evaluation of the antioxidant potential of natural products. *Comb. Chem. High Throughput Screen*. **1998**, *1*, 35-46.
16. Hişil Y. *Instrumental Analysis Techniques* (Eng Fac Publ 55). Ege Üniversity, Bornova -İzmir. (in Turkish) (1988).

17. Skujins S. Handbook for ICP-AES (Varıan-Vista). *A Short Guıde To Vista Series ICP-AES Operation*.Varian Int.AGşZug.Version 1.0. pp 29. Switzerland,1998.
18. Püskülcü H, İkiz F. *Introduction to Statistic*. Bilgehan Press. p333. Bornova. İzmir,Turkey, (1998) . (in Turkish)
19. Cozzolino S M F. *Biodisponibilidade de nutrients*. Sao Paulo: Manole (2005).
20. Peterson LN. *Potassium in nutrition*. In: O'Dell, B.L.,Sunde, R.A., *Handbook of nutritionally essential minerals*. New York: Marcel Dekker (1997).