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RESEARCH ARTICLE

Physicochemical analysis and nutritional properties of fresh, osmo-dehydrated and dried chayote (*Sechium edule* L.)

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ABSTRACT

The present study was aimed to investigate the physicochemical, nutritional properties of fresh, osmo-dehydrate and dried chayote. The fresh, osmo-dehydrated and dried chayote chayote was analyzed at different conditions, had considerable amount of moisture content, Ash, crude fiber, crude protein total carbohydrate, total fat, pH, acidity, and ascorbic acid. The important quality parameter as total colour change for fresh, osmo-dehydrated and dried chayote also investigated. The present observation showed that the both fresh and osmo-dehydrated chayote can be acceptable as good source of physicochemical and nutritional properties. The oven dried chayote was found to be maximum colour changes and ascorbic acid as compared to osmo-dehydrated chayote.

Keywords: Osmotic dehydration, chayote, physicochemical, nutritional analysis

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INTRODUCTION

Chayote (*Sechium edule* L.), is a seasonal vegetable crops belongs to gourd family *Cucurbitacae* cultivated in tropical and subtropical region. It is a tender perennial vine type plant that produces a peer shaped, pale green to white, mild flavor and crispy textures having single seed, feasible in warm season for high productivity and growth. Chayote is known for high fiber, low lipid, protein, and calorie content, but it is vital source of minerals, amino acids, and vitamins (Lira-Saade, 1996; Cadena-Iniguez et al., 2006). The researchers reported that the vegetable exhibited diuretic and anti-inflammatory properties (Aung et al., 1990; Ordonez et al., 2006). The plant is originated in Central America and widely grown throughout the world in the region of Maxico, Africa, Brazil, China, Malaysia, India, Malaysia, Thailand etc. However, it has been occupied an important vegetables for its inherent qualities and huge market demand (Kumar et al., 2017). In India, chayote was called different vernacular names are squash (Assamese), quash (Bengali), chow chow (Hindi), dashkush (Manipuri), seemakattirikkai (Tamil), seemebadane (kannada), phuti kakudi (Oriya), respectively. The chayote has been gaining popularity for its multiple applications like cooked vegetables, fermented pickles, candy, juice, murabba, cakes and snake foods. Hence, consumer is

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preferred to chayote instead of other vegetables like potato, gourd, brinjal for its varied uses and potential health benefits. Chayote contain high moisture content of 87-95% on wet basis, which can led to extensive post harvest losses by microbial and chemical deterioration, improper handling, distribution, and storage (Lira-Saade, 1996; Perez-Francisco et al., 2008; Villers, 2015). Since, fresh chayote cannot be stored for more than 6-7 days in normal ambient conditions, but shelf life can be extended by various processing methods such as fermentation, pickling, canning or cold storage, drying, and osmotic dehydration. Therefore, a moisture removal method has been adopted to promote its value addition and shelf life extension, which were drying and osmotic dehydration. In this present study, the investigation was carried out to determine the physicochemical and nutritional properties of fresh, osmo-dehydrated and oven dried chayote.

MATERIALS AND METHODS

Raw material

The fresh and well graded chayote samples were procured from the Irongmara market, Silchar, Assam (India) on a daily basis prior to each set of experiment. Table salt NaCl was used for the preparation of brine solution and also purchased from local market.

Samples Preparation

The samples were washed and peeled manually by knife and then divided into uniform cubical size of 1 cm3. Blanching was not done prior to osmosis due to loss of semi-permeability of cell membranes (Ponting, 1973). In this study, salt solution was chosen for osmosis, as it is an excellent osmotic agent for vegetables retarding oxidative and non-enzymatic browning (Jackson and Mohammed, 1971). A known amount of chayote cubes with desired optimum salt concentration of 11%, temperature 36^{o}C and sample to solution ratio 1:11 were immersed into Erlenmeyer flask of 500 ml and then kept in an incubator shaker (Scientech Instrument, Delhi, India) for 186 minutes (Kumar et al., 2017). After that chayote cubes were taken out, rinsed with distilled water and then blotted up with tissue paper to remove the free water on the surface. For hot air oven drying, a known amount of chayote cubes were taken and then dried at 55^{o}C for 24 hours into hot air oven (Reico Equipment and Instrument, Kalkata, India). Dried chayotes were grounded using a blender and stored in air tight container for subsequent analysis.

Determination of moisture content

The moisture content of the sample was determined by the hot air oven method (AOAC, 2000). For initial moisture content, about 3 g of fresh sample was placed in hot air oven at 105±1^{o}C for 8-9 h or till constant weight. The following equation was used for moisture content determination:

$$\text{Moisture Content (\% wb)} = \frac{\text{Initial weight(g)} - \text{Final weight(g)}}{\text{Initial weight (g)}} \times 100 \qquad (1)$$

Determination of crude protein content

The estimation of protein content was analysed by Micro-Kjeldhal method and the procedures were described in AOAC method (2000). The nitrogen content was calculated using the following equation:

$$\text{Nitrogen (\%)} = \frac{(\text{ml HCl} - \text{ml blank}) \times \text{Normality of HCl} \times \text{Dilution factor} \times 14.01}{\text{Weight (g)}} \times 100 \qquad (2)$$

$$\text{Protein content (\%)} = \text{\% of Nitrogen} \times 6.21 \quad (3)$$

Determination of crude fiber content

The crude fibre content was determined by the digestion flask method described in AOAC method (2000). Percentage of crude fibre was calculated using the following equation:

$$\text{Crude (\%)} = \frac{\text{Loss in weight on ignition } (W_2 - W_1) - (W_3 - W_1)}{W_s} \times 100 \quad (4)$$

Where, W_1 = Pre-weight dish, g, W_2 = Weight of residue, g, W_3 = Weight of ignited sample, g

Determination of fat content

The fat content of the samples were determined by the Soxhlet extraction method (AOAC, 2000) using Soxhlet apparatus. Percentage of fat content was calculated by the following equation:

$$\text{Fat (\%)} = \frac{W_f}{W_s} \times 100 \quad (5)$$

Where, W_s= Weight of fat, g,W_s= Weight of sample, g

Determination of ash content

Determination of the ash content of the samples was performed by the method described in AOAC method (1990). The ash content was computed using the following equation:

$$\text{Ash (\%)} = \frac{W_d}{W_s} \times 100 \quad (6)$$

Where, W_d= Weight of dry ash residue, g,W_s = Weight of chayote sample, g

Determination of total carbohydrate content

The total carbohydrate was determined by Anthrone Method (AOAC, 2000). A 100 mg of chayote samples boiled into boiling tube and hydrolyse by keeping it in a boiling water bath for 3 hrs with 5 ml of 2.5 N HCl and then cooled to a room temperature. It was neutralised with solid sodium carbonate until the effervescene ceases and make up the volume to 100 ml and centrifuged. The supernatant was collected and taken 0.5 and 1 ml aliquots for analysis. The standards were prepared by taking 0, 0.2, 0.4, 0.6, 0.8 and 1 ml of the working standard. '0' serves as blank. The volume was made up to 1 ml in all the tubes including the sample tubes by adding distilled water and then added 4 ml of anthrone reagent. The sample tubes heated for 8 minutes in a boiling water bath. After heating the sample tubes were cooled rapidly and read the green to dark green colour at 630 nm. The amount of carbohydrate present in the sample tube was calculated by using the following equation:

$$\text{Carbohydrate (mg/100 mg)} = \frac{G}{W_t} \times 100 \quad (7)$$

Where, G = Amount of glucose, mg, W_t= Volume of test sample, ml

Determination of p^H

The pH of the samples was determined using digital p^H meter (Denver Instrument, model 202). The instrument was calibrated and standardized with buffer solutions at 7.0. A 5 g of chayote samples were added in 10 ml distilled water and mixed up properly until getting a uniform paste and then an electrode was dipped into the samples (Yohannes *et al*., 2013).

Determination of titratable acidity

Titratable acidity of the samples was determined according to the method described by AOAC method (2000). A 1 g of ground samples of each fresh, osmo-dehydrated and oven dried chayotes used for the determination of titratable acidity. A phenolphthalein was used as an indicator and the samples titrated against 0.1 N NaOH. The following equation was used to calculate the acidity:

$$Acidity\ as\ citric\ acid(\%) = \frac{\text{Titre value} \times \text{Normality of NaOH} \times \text{Eqv.weight} \times \text{Vol.made up} \times 100}{\text{Volume of sample taken for estimation} \times \text{Wt.or vil.of sample taken} \times 1000} \quad (8)$$

Determination of ascorbic acid

Vitamin C of the samples was determined by 2, 6-dichlorophenol-indophenols using the procedure as described in AOAC method (1990). A 2 g of ground samples were mixed in 4% oxalic acid and made up to known volume (100 ml) and centrifuge. Initially Pipetted out 5 ml of the working standard solution into a 100 ml conical flask. Added 10 ml of 4% oxalic acid and titrate against the dye (V_1 ml). End point is the appearance of pink color which persists for a few minutes. The amount of the dye consumed is equivalent to the amount of ascorbic acid. Again Pipetted out 5 ml of this supernatant, add 10 ml of 4% oxalic acid and titrate against the dye (V_2 ml).

$$\text{Ascorbic acid}\left(\frac{\text{mg}}{100}\text{g}\right) = \frac{0.5\ \text{mg}}{\text{V}_1\text{ml}} \times \frac{V_2\ ml}{5\ ml} \times \frac{100\ \text{ml}}{\text{W}_s} \times 100 \quad (9)$$

Where, V_1 = Volume of 4% oxalic acid mixed with ground sample, ml, V_2 = Volume of supernatant in addition with 10 ml of 4% oxalic acid, ml,W_s= Weight of the sample, g.

Total colour change

Color is the most important parameters for acceptability of the product. The color change of fresh, osmo-dehydrated and dried chayote was measured in terms 'L', 'a', and 'b' values. The CIE (International Commission on Illumination) L, a, b color values of fresh, osmo-dehydrated samples were obtained by a Hunter Color Lab. The 'L' indicates darkness-lightness, 'a' redness–greenness, and b yellowness–blueness. The total colour change was calculated using the following equation (Gnanasekharan *et al*., 1992):

$$\Delta E = \sqrt{[\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]}$$

$$\Delta E = \sqrt{[(L_1\text{-}L_2)^2 + (a_1\text{-}a_2)^2 + (b_1\text{-}b_2)^2]} \quad (10)$$

Where, ΔL=Varies from 0 (darkness) to 100 (lightness), Δa= Variation in the hue parameter-from red (+) to green (-), Δb=Variation in the hue parameter-from yellow (+) to blue (-), L_1, a_1 and b_1 are the color values of raw sample, L_2, a_2 and b_2 are the color values of osmo-dehydrated and dried samples.

Statistical analysis

All the experiments were carried out in four replications, and the values were taken as mean along with their standard deviations. The data obtained from the study were subjected to a completely randomized design (CRD) and statistically evaluated with one way analysis of variance (ANOVA) at 5% confidence level by LSD test using SPSS 20.0 version software (SPSS Inc., Chicago, IL, USA), $p<0.05$ regarded as significant.

RESULTS AND DISCUSSION

The results of the present study on "Physicochemical Analysis and Nutritional Properties of Fresh, Osmo-dehydrated and Dried Chayote (*Sechium edule*) are discussed in this chapter.

The proximate composition of fresh, osmo-dehydrated and oven dried chayotes are shown in Table 1. Drying reduced the moisture content of chayotes. The initial moisture content of the samples was found to be 93.27% in wet basis and osmotic dehydration was taken an important role for partial reduction of moisture content 63.58%, while oven dried samples had 10.32% moisture content. The higher moisture content reduction of the samples were obtained in oven drying, which probably due to high and controlled temperature in the system (Eze and Akubor, 2012).

Table 1. Proximate composition of fresh, osmo-dehydrated, dried chayotes

Compositions (%)	Fresh chayote	Osmo-dehydrated chayote	Oven dried
Moisture	93.27^{b}±0.16	63.58^{a}±0.26	10.18^{d}±0.34
Ash	0.30^{a}±0.04	0.45^{c}±0.02	0.21^{b}±0.05
Crude Protein	0.84^{a}±0.04	0.69^{a}±0.05	0.48^{b}±0.07
Fat	0.15^{b}±0.02	0.09^{a}±0.02	0.06^{a}±0.03
Crude fiber	0.27^{c}±0.06	0.30^{a}±0.03	0.32^{c}±0.08
Total carbohydrate	4.42^{a}±0.09	3.66^{b}±0.12	3.02^{a}±0.07

*Results are expressed as mean ± Std. Dev.

The osmotic dehydration process has a significant influence for the subsequent drying and quality of final product. Among the process condition tested, solution concentration and immersion time was found to exert more profound influence over the physicochemical properties of the final product (Kumar et al., 2017). The ash content of fresh chayote was 0.30% and osmo-dehydrated product was 0.45%, which is significantly higher than that of fresh chayote 0.30% and oven dried chayote of 0.21%. The ash content increases with increase of drying temperature, which is attributed to concentration factor of osmotic solution due to moisture removal resulting in higher level of total soluble solid in the samples (Alakali et al., 2015). However, the crude protein content of fresh samples was found about 0.84%, which is decreased to 0.69% after osmotic dehydration in brine solution, while it decreases to 0.48%. Similarly, the fat content was also reduced from 0.15 to 0.09% during osmotic dehydration and oven dried samples was 0.06%, which were also not significantly higher than that of fresh chayote. The crude fiber of the raw sample was to be found 0.27%. After osmotic dehydration with a given set of process conditions, the fiber content was obtained 0.30%, which was slightly higher than that of fresh chayote. The total carbohydrate of the fresh chayote 4.42%, which was reduced to 3.66% in osmo-dehydrated samples and 3.02% in oven dried samples. The similar observation

revealed that the decreasing trend of crude protein, fat, fiber and carbohydrate contents of the dried samples on dry weight basis and increasing of other components in the proximate composition of fresh and dried okra samples at different drying conditions (Suna et al., 2014).

Table 2. Physicochemical properties of fresh, osmo-dehydrated and dried chayotes

Parameters	Fresh chayote	Osmo-dehydrated chayote	Oven dried
p^H	6.26^{a}±0.02	6.52^{b}±0.04	6.40^{a}±0.01
Titratable acidity (% Citric acid)	0.96^{c}±0.05	1.20^{c}±0.03	1.02^{a}±0.04
Ascorbic acid (mg/100g)	7.82^{b}±0.04	4.38^{c}±0.07	2.66^{a}±0.06
Total Colour change (ΔE)	0.00±0.00	18.14^{a}±0.42	68.87^{b}±0.97

*Results are expressed as mean ± Std. Dev.

Several researchers reported that the ascorbic acid is a heat sensitive substance (Suna et al., 2014; Emese and Nagymate, 2008; Bello and Fowoyo, 2014). In this study, the ascorbic acid content was found to be 7.82 mg/100 g in fresh chayote, which was reduced to 4.38 mg/100 g after osmotic dehydration, but a very low ascorbic acid was obtained in oven dried chayote. The trends of reduction of the physicochemical properties were reported by Lee (2014) in kappaphycusalvarezii during osmotic dehydration. Increased in temperature and water removal generally cause a loss of chemical compounds, which mainly affects the antioxidant activity of plant materials (Manzocco et al., 2001).

The Hunter Color L, a, b values were observed in fresh, osmo-dehydrated and oven dried chayote cubes at given set of conditions. The total color change (ΔE) was found to be 18.14 between fresh and osmo-dehydrated product, which indicated the color change does not affects much quality of the product at that process conditions and that can be considered as desirable quality of the product. In case of oven dried samples, the total colour change was obtained 68.87, which was drastically affected the quality of product. Total color change showed significantly increase with the increase in concentration and immersion time while the increase in temperature and STSR. This was mainly attributed to enzymatic browning escalated by longer time exposure to air as well as the shrink of cell matrix of chayote cubes caused by increased water loss during dehydration and oven drying which changed their optical performance and led to total color change increased (An et al., 2013).

CONCLUSIONS

The osmo-dehydrated chayote samples were treated at given set of conditions and compared with fresh and oven dried samples for proximate and physicochemical properties. The results of showed that the final product contained high crude fiber (0.35 g/100 g) compare to fresh sample (0.27 g/100 g) and moisture content reduced from 93.27% to 63.58% during osmotic dehydration. In this study, the total color change was obtained 18.14 compare to oven dried samples of 68.87, which indicated that the color change does not highly affect the product quality. In case of oven dried samples, the total colour change was affected the product quality. The concentration and temperature has found more profound effect on color. The results revealed that the osmotic dehydrated chayote was considerable level of good quality dehydrated product. The proximate composition of nutritional properties had substantially changed in comparison of fresh sample and was found to be less effect on osmo-dehydrated product.

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