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Production of Dried Tea from Okra (*Abelmoschus Esculentus)*

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Abstract.
Okra *(Abelmoschus esculentus)* has its high moisture content. It is subjected to rapid deterioration, resulting in chemical, physical and biological changes. Size reduction and drying of okra pods will facilitate easy packaging, storage and transport**.** Drying process offer an alternative way of using okra thus, preventing the huge post-harvest losses and make them available in the offseason. Thus, this study aimed to investigate technical aspects affecting to production of dried okra instant tea such as blanching temperature and time, size of slice okra, drying temperature and time, storage condition. Results showed that dried tea from okra could be obtained by blanching at 95°C in 20 seconds with slice size 1.5cm , drying at 50°C keeping in PET/AL/PE bag in 8 weeks without any deterioration.

Keywords: *Okra, blanching, size, drying, storage, dried tea*

I. Introduction

Okra *(Abelmoschus esculentus)* is a flowering plant, tropical perennial crop. It can be consumed as a fresh vegetable, cooked vegetable or an additive for soups, salads and stews. Freshly harvested okra pods can be sliced, dried and grounded into powder for extension of shelf life (Sobukola, 2009). Okra is a good source of carbohydrate, protein, dietary fibre, calcium, magnesium, potassium, vitamins A and C (Nahry et al. 1978; Adom et al. 1996; 1997; Sobukola 2009). Okra contains glycans, a substance responsible for the viscosity of aqueous suspension (Owoeye et al. 1990) and the stringy, gum like consistency that is desired in good quality soups (Falade and Omojola 2010). Okra has polysaccharide content giving a strong viscous and sticky solution appearance (Sengkhamparn et al., 2008). it has medicinal use to fight against some cardiovascular and dental diseases and decreases gastric irritations. It is also used as diuretic agent. These properties of okra are due to its contain in oligomerics catechins, derived flavonol, and polyphenol with hydroxycinnamic and quercetins (Adelakun, O.E et al., 2009).

Okra is highly perishable because of its high moisture content and respiratory activities, thus it is necessary to dry them for prolong use (Falade and Omojola, 2010). drying process is a heat and mass transfer phenomenon where water migrates from the interior of the drying product to the surface from where it evaporates (Adesoji Matthew Olaniyan and Bamidele David Omoleyomi, 2013). Sun drying is inexpensive drying technique, but has many drawbacks (Doymaz**,** 2005). Therefore, to overcome these problems okra is dried in solar or hot air driers more effectively (Doymaz and Pala, 2005; L. G. Bakre, K. T. Jaiyeoba, 2009; Mohamed M. A, G. R. Gamea, 2010; Ismail, M.A. and Ibn Idriss, E.M., 2013; J. B. Hussein et al., 2018). Microwave drying of okra has also been done (Dadali et al. 2007; Mohammed A. Al-Sulaiman, 2011). The drying characteristics of okra has been reported by research workers (Gögus and Maskan 1999; Doymaz 2005; Dadali et al. 2007; Ouoba Kondia Honoré et al., 2014; Famurewa J. A. V. & Olumofin, K. M., 2015)**.**

There were several studies menioned to the drying process of okra. Pendre N. K. et al. (2012) proved the effect of drying temperature and slice size on quality of dried okra. Jiokap Nono Yvette et al. (2015) demonstrated the possibility of improving the storage quality of dried okra through the combined dewatering-impregnationsoaking process/blanching pre-treatment, reducing post-harvest losses and improving the market quality of dry products. Eli Kolo Tsado (2015) demonstrated that the direct sun dried sliced okra fruits produced the best dry quality, followed by close sun drying method while oven drying of okra achieved the least acceptance. Neel Kamal Pandre et al. (2018) conducted to see the effect of drying temperature and slice size on physical properties of drying okra.

Okra has poor shelf life due to the quick degeneration and decomposition of it after harvest. Drying process offer an alternative way of using okra thus, preventing the huge post-harvest losses and make them available in the offseason. Thus, this study aimed to investigate technical aspects affecting to production of dried okra instant tea such as blanching temperature and time, size of slice okra, drying temperature and time, preservation.

II. Materials And Method

2.1 Material

We collected okra in Da Nang province, Vietnam. They must be cultivated following VietGAP to ensure food safety. After harvesting, they must be conveyed to laboratory within 4 hours for experiments. They were washed thoroughly under tap water to remove dirt,dust and adhered unwanted material. Besides okra we also used other materials during the research such as PET/AL/PE, 3M-Petrilm. Lab utensils and equipments included blanching oven, thermometer, sieve, knife, chop board, dryer, viscometer, cyclinder, stomacher, vortex, incubator, refrigerator, colony counter, titrimetor.

Figure 1. Okra *(Abelmoschus esculentus)*

2.2 Researching procedure

2.2.1 Effect of blanching temperature and time on quality of dried okra

Okra samples were cut into slice of 2.0cm and blanched in NaCl solution (0.5%) at different time and temperature (100^{o}C for 15 seconds, 95^{o}C for 20 seconds, 90^{o}C for 25 seconds and 85^{o}C for 30 seconds). The blanched samples were immediately cooled by immersing in cold water. Then blanched samples were spread on a stainless steel sieves to drain excess water (Shivhare *et al*., 2000). All treated samples will then be dried at 60^{o}C to 15% moisture content. Bulk density (g/ml), true density (g/ml), shrinkage ratio (%), rehydration ratio (%) of dried okra were used as indicator to prove the effectiveness of treatment.

2.2.2 Effect of slice size on quality of dried okra

Okra samples were cut into different slice sizes of 0.5 cm, 1.0 cm, 1.5 cm and 2.0 cm by using cut and chop board. For getting desired size of slices markings were made on the cut and chop board and the samples were fixed to the board with the help of wooden (Neel Kamal Pandre *et al.,* 2018). All treated samples will then be dried at 60^{o}C to 15% moisture content. Bulk density (g/ml), true density (g/ml), shrinkage ratio (%), rehydration ratio (%) of dried okra were used as indicator to prove the effectiveness of treatment.

2.2.3 Effect of drying temperature on quality of dried okra

Okra samples were cut into slice of 1.0cm and blanched in NaCl solution (0.5%) at 100^{o}C for 15 seconds. The experiment laid out with five drying temperatures (40, 45, 50, 55 and 60°C) on quality of okra were studied (Neel Kamal Pandre *et al.,* 2018). Bulk density (g/ml), true density (g/ml), shrinkage ratio (%), rehydration ratio (%) of dried okra were used as indicator to prove the effectiveness of treatment.

2.2.4 Effect of storage conditions on quality of dried okra

Two different storage conditions were experimented. One portion was packed in filter bag and another was packed in PET/AL/PE bag. Both of them were kept in ambient temperature. The dried samples were analysed before storage (at zero week) and afer storage (at 8th week) for proximate composition such as moisture, protein, fat, ash, fibre, carbohydrate, energy value (Kcal), viscosity (cP) and vitamin C (mg/100 g).

2.3 Physico-chemical and biological analysis

2.3.1 Bulk density (g/ml)

Bulk density used to specify the quality of product, was measured by pouring a known mass of the sample into a 1000 ml cylinder and reading the volume after gently tapping the cylinder twice (Shivhare *et al*., 2000). The bulk density may be expressed as below: Bulk density (g/ml) = M/V

Where, M = Mass of sample, g V = Volume of the sample, ml

2.3.2 True density (g/ml)

True density is an important factor for heat and mass transfer analysis through products. For determination of true density, known volume of water was taken in a measuring cylinder of 1000 ml capacity. The samples were dipped in the water containing measuring cylinder. The rise in the level of water is noted and true density is obtained by dividing the mass of the sample by increase in the water volume (Neel Kamal Pandre *et al.,* 2018). True density (g/ml) = M/(V2 – V1)

Where, M = Mass of sample, g V1= Volume of water after dipping the sample, ml V2= Volume of water before dipping the sample, ml

2.3.3 Shrinkage ratio (%)

Shrinkage ratio is specify the quality of okra was measured by pouring a know volume of the sample into 500 ml cylinder and reading the volume after gently tapping the cylinder twice (Ranganna *et al.,* 1986). Shrinkage ratio of any material may be expressed as below: Shrinkage ratio (%) = V_d/ V_f

Where, V_d = Volume of dried sample, ml V_f = Volume of fresh sample, m

2.3.4 Rehydration ratio (%)

Rehydration ratio was obtained by dividing mass of the rehydrated sample by mass of the dried sample. Rehydration of the dried sample was carried out by adding 80 ml distilled water to 5 g dried okra slices contained in a 500 ml beaker. The beaker was covered with aluminum plate and the contents were brought to boiling point within 3 min. and the boiling was continued for 10 min (Shivhare *et al*., 2000). Excess water was removed by placing the sample on a stainless steel sieve and mass of the rehydrated sample was determined.

2.3.5 Determination of chemical composition of fresh and dried okra

Samples of fresh and dried Okra were analyzed for the following parameters, moisture, protein, fat, ash, fibre, carbohydrate, energy value (Kcal), Viscosity (cP) and Vitamin C (mg/100 g). The moisture content was determined (AOAC, 2004). The samples were dried at 105°C for 4 hours using the preset oven.

The method described (AOAC, 2004) was employed for ash content determination. The crucibles containing the pre-weighed samples were placed in a heated furnace at 600°C for 6 hours after which they were cooled to room temperature in desiccators and weighed. The protein content (% nitrogen x 6.25) and fat content (1 g was extracted for ether extract determination using diethyl ether at 64°C as solvent) were determined (AOAC, 2004). The carbohydrate content was determined by difference between 100 and total sum of the percentage of moisture, protein, fat, fibre and ash (AOAC, 1990). Energy values were calculated using Atwater factors of 4, 4 and 9 Kcal for protein, carbohydrate and fat respectively. A rotational viscometer was used to determine the viscosity. Vitamin C was determined (AOAC 2010) official titrimetry method.

2.3.6 Sensory evaluation

For sensory evaluation, the product was evaluated by a panel of 30 semi trained panelists. Panelists were required to evaluate the odour, colour, taste, sweetness and overall acceptance using the 9-point hedonic scale (1 = dislike extremely, 9 = like extremely).

2.3.7 Microbial analysis

3M-Petrilm was used to analyze yeast and mold.

2.4 Statistical analysis

The experiments were run in triplicate with three different lots of samples. Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan's multiple range test (DMRT). Statistical analysis was performed by the Statgraphics Centurion XVI.

III. RESULT & DISCUSSION

3.1 Chemical composition in fresh okra

Chemical composition in fresh okra was mentioned in table 1.

Table 1. Chemical composition in fresh okra

Parameter	Value
Moisture (%)	74.87±0.02
Crude protein (%)	12.05±0.01
Crude fat (%)	0.31±0.01
Crude ash (%)	1.05±0.02
Crude fibre (%)	0.51±0.00
Carbohydrate (%)	10.52±0.01
Energy value (Kcal)	93.08±0.01
Viscosity (cP)	12.75±0.01
Vitamin C (mg/100 g)	26.17±0.03

Chemical composition of fresh okra in this research was similar with finding by J. B. Hussein et al., (2018).

3.2 Effect of blanching temperature and size on quality of dried okra

Okra samples were cut into slice of 2.0cm and blanched in NaCl solution (0.5%) at different time and temperature (100°C for 15 seconds, 95°C for 20 seconds, 90°C for 25 seconds and 85°C for 30 seconds). The blanched samples were immediately cooled by immersing in cold water. Then blanched samples were spread on a stainless steel sieves to drain excess water. All treated samples will then be dried at 60°C to 15% moisture content. Results were depicted in table 2. From table 2, the blanching should be conducted at 95°C in 20 seconds.

Compared to simple blanching, the dewatering-impregnation soaking process/blanching pre-treatment yielded dry products that were better appreciated both to the touch and to the sight. The combined dewatering-impregnation soaking process/Blanching and drying process gave averages of (78.1 ± 3.6) % weight reduction, (9.1 ± 0.5) % solute gain and (87.2 ± 4.0) % water loss. The total water loss was due at 35.6 % to the dewatering-impregnation soaking process/blanching pre-treatment and at 64.4 % to the further drying process (Jiokap Nono Yvette et al., 2015). Eze Ji and Akubor Pi (2012) showed that blanching followed by oven or sundrying decreased the moisture, vitamins A and C concentrations but increased the, protein, ash, iron, zinc, calcium and magnesium contents of the okra fruits.

Table 2. Effect of blanching temperature and size on bulk density (g/ml), true density (g/ml) shrinkage ratio (%), rehydration ratio (%) of dried okra

Blanching	100 °C, 15 seconds	95 °C, 20 seconds	90 °C, 25 seconds	85°C, 30 seconds
Bulk density (g/ml)	0.55±0.02^{a}	0.54±0.01^{a}	0.54±0.00^{a}	0.54±0.03^{a}
True density (g/ml)	1.22±0.00^{a}	1.21±0.03^{a}	1.21±0.02^{a}	1.20±0.02^{a}
Shrinkage ratio (%)	4.23±0.02^{c}	2.49±0.01^{d}	6.23±0.00^{b}	7.53±0.03^{a}
Rehydration ratio (%)	6.17±0.01^{b}	7.45±0.03^{a}	5.38±0.02^{c}	4.55±0.01^{d}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 3. Effect of okra slice size (cm) on bulk density (g/ml), true density (g/ml), shrinkage ratio (%), rehydration ratio (%) of dried okra

Slice size of okra (cm)	0.5	1.0	1.5	2.0
Bulk density (g/ml)	0.53±0.02^{a}	0.53±0.02^{a}	0.53±0.02^{a}	0.54±0.01^{a}
True density (g/ml)	1.20±0.01^{a}	1.20±0.01^{a}	1.20±0.01^{a}	1.21±0.03^{a}
Shrinkage ratio (%)	2.07±0.02^{d}	2.11±0.02^{c}	2.34±0.00^{b}	2.49±0.01^{a}
Rehydration ratio (%)	7.76±0.01^{a}	7.74±0.01^{a}	7.68±0.01^{ab}	7.45±0.03^{b}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 4. Effect of drying temperature (°C) on bulk density (g/ml), true density (g/ml), shrinkage ratio (%), rehydration ratio (%) of dried okra

Drying temperature (°C)	40	45	50	55	60
Bulk density (g/ml)	0.53±0.01^{a}	0.53±0.00^{a}	0.53±0.01^{a}	0.53±0.01^{a}	0.53±0.02^{a}
True density (g/ml)	1.20±0.01^{a}	1.20±0.02^{a}	1.20±0.02^{a}	1.20±0.02^{a}	1.20±0.01^{a}
Shrinkage ratio (%)	2.07±0.02^{c}	2.19±0.03^{bc}	2.23±0.01^{b}	2.26±0.01^{ab}	2.34±0.00^{a}
Rehydration ratio (%)	7.95±0.03^{a}	7.89±0.02^{ab}	7.82±0.02^{b}	7.75±0.03^{bc}	7.68±0.01^{c}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 5. Effect of storage condition on chemical composition in dried okra

Kind of packing	Filter bag		PET/AL/PE bag	
Date of sampling	Zero week	8th week	Zero week	8th week
Moisture (%)	15.00±0.01[a]	15.23±0.02[a]	15.00±0.01[a]	15.14±0.02[a]
Crude protein (%)	22.05±0.02[a]	22.02±0.01[a]	22.05±0.02[a]	22.02±0.01[a]
Crude fat (%)	2.31±0.01[a]	2.29±0.02[a]	2.31±0.01[a]	2.29±0.03[a]
Crude ash (%)	9.22±0.03[a]	9.19±0.01[a]	9.22±0.03[a]	9.20±0.01[a]
Crude fibre (%)	7.99±0.01[a]	7.93±0.02[a]	7.99±0.01[a]	7.94±0.02[a]
Carbohydrate (%)	44.87±0.02[a]	44.73±0.03[a]	44.87±0.02[a]	44.75±0.03[a]
Energy value (Kcal)	285.17±0.03[a]	284.01±0.02[a]	285.17±0.03[a]	284.15±0.01[a]
Viscosity (cP)	11.84±0.01[a]	11.23±0.02[a]	11.84±0.01[a]	11.24±0.02[a]
Vitamin C (mg/100 g)	16.93±0.02[a]	16.48±0.01[a]	16.93±0.02[a]	16.56±0.01[a]

3.3 Effect of okra slice size on quality of dried okra

Okra samples were cut into different slice sizes of 0.5 cm, 1.0 cm, 1.5 cm and 2.0 cm by using cut and chop board. For getting desired size of slices markings were made on the cut and chop board and the samples were fixed to the board with the help of wooden. All treated samples will then be dried at 60°C to 15% moisture content. Results were elaborated in table 3. Results revealed that the okra slice size should be 1.5 cm.

Neel Kamal Pandre et al. (2018) proved that the maximum bulk density (0.23g/ml) was found in 1 cm slice size whereas, minimum true density (0.31g/ml) was found under 2 cm slice size. The minimum shrinkage ratio of dried okra (0.17) was found under 1 cm slice size. The maximum rehydration ratio (6.75) was found under 1 cm slice size.

3.4 Effect of drying temperature on quality of dried okra

Okra samples were cut into slice of 1.0cm and blanched in NaCl solution (0.5%) at 100°C for 15 seconds. The experiment laid out with five drying temperatures (40, 45, 50, 55 and 60°C) on quality of okra were studied. Results noted that drying temperature should be conducted at 50°C.

During drying many changes take place; structural and physic-chemical modifications affect the final product quality, and the quality aspects involved in dry conversation in relation to the quality of fresh products and applied drying techniques (Wankhade P.K., 2013). The sample dried at 40°C was found better in color texture and taste as compared to the samples obtained at 60 and 90°C (Wankhade P.K., et al., 2013). Neel Kamal Pandre et al. (2018) proved that the maximum bulk density (0.23g/ml) was found in combination of 50 °C, minimum true density (0.31g/ml) was found under 60 °C. The minimum shrinkage ratio of dried okra (0.17) was found under 70 °C. The maximum rehydration ratio (6.75) was found under 50 °C.

3.5 Effect of storage condition on quality of dried okra

Two different storage conditions were experimented. One portion was packed in filter bag and another was packed in PET/AL/PE bag. Both of them were kept in ambient temperature. The dried samples were analysed before storage (at zero week) and afer storage (at 8th week) for proximate composition such as moisture, protein, fat, ash, fibre, carbohydrate, energy value (Kcal), viscosity (cP) and vitamin C (mg/100 g). Results were clearly mentioned in table 5.

Chemical composition of dried okra in this research was similar with finding by J. B. Hussein et al., (2018). Jiokap Nono Yvette et al. (2015) demonstrated the possibility of improving the storage quality of dried okra through the combined dewatering-impregnationsoaking process/blanching pre-treatment, reducing post-harvest losses and improving the market quality of dry products. Eze Ji and Akubor Pi (2012) showed that the viscosity and moisture content of the samples decreased during storage, regardless of the storage conditions. However, the blanched and oven-dried okra samples packaged in air-tight container and stored in dark, cool place, retained more of its chemical constituents and viscosity than the other stored samples.

IV. CONCLUSION

The main purpose of drying is the reduction of the moisture content to a safe level. The removal of moisture prevents the growth and reproduction of microorganisms as well as enzymatic reactions. It brings about significant reduction in weight and volume, minimizing packing, storage and transportation costs as well as enables storability of the product under ambient temperatures. We have successfully investigated some technical aspects affecting to production of dried okra dried tea such as blanching temperature and time, size of slice okra, drying temperature and time, storage condition.

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