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Standardization of Pretreatment for dehydration of Okra (*Abelmoschus esculentus* L. Moench)

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Abstract
The study was conducted to know the suitability of pre-treatment for dehydration of okra (*Abelmoschus esculentus* L. Moench). The experiment consists pre-treating of Arka Nikhita (Harvested at 4 days after anthesis) either blanched or brined or combination of both before dehydration and assessed for physico-chemical characters. T_4 (Brining solution concentration 1.0%) treatment recorded maximum dry matter, rehydration ratio, chlorophyll content, magnesium, calcium and iron and recorded minimum dehydration ratio and crude fiber content. The results also shown that T_4 (Brining solution concentration 1.0%) treatment recorded maximum score for overall acceptability.

Keywords: Okra, pretreatment, dehydration

Introduction
Okra (*Abelmoschus esculentus*) is one of the most widely known and utilized species of the family Malvaceae (Naveed *et al.*, 2009) [23] and an economically important vegetable crop grown in tropical and sub-tropical parts of the world (Saifullah and Rabbani, 2009) [27]. The plant was previously included in the genus *Hibiscus*. Later, it was designated to *Abelmoschus*, which is distinguished from the genus *Hibiscus* (Aladele *et al.* 2008) [1]. Okra originated in Ethiopia (Sathish & Eswar, 2013) [28] and was then propagated in North Africa and in India by the 12th century BC (Nzikou *et al.*, 2006) [25].
The fruits are a green capsule containing numerous white seeds when immature (Jesus *et al.*, 2008) [15] and the flowers and upright plants give okra an ornamental value. The okra fruit can be classified based on the shape, angular or circular (Mota *et al.*, 2005) [22]. It is a popular ingredient of soups and stews where a highly viscous consistency is desired (Baxter and Waters, 1990) [2]. Okra has a high nutritional value and grows very quickly with high temperatures, which lends its production to more tropical parts of the world. Okra seeds are a source of oil, protein and are also used as a coffee substitute, while ground-up okra seeds have been used as a substitute for aluminium salts in water purification (Camciuc *et al.*,1998) [3].
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) [8]. The demand of okra is so high that at times okra has to be imported. On the other hand, due to poor post-harvest management okra losses are quite high and also the processing of okra is very limited. The traditional method for preserving okra (Kordylas, 1991) [18] involves slicing and sun drying of the pods until they become brittle, followed by milling into powder for further use. It is also a constituent of Indian food/curries, drying enhances its keeping quality. Sun drying is inexpensive drying technique, but has many drawbacks (Doymaz, 2005) [4]. Therefore, to overcome these problems okra is dried in solar or hot air driers more effectively (Doymaz and Pala, 2002). Raghavan *et al.* (2005) [26] indicated that about 34% of the world produce requires artificial drying. The drying characteristics of okra has been reported by research workers (Dadali *et al.*, 2007) [5].
Pre-treatment before dehydration will not only reduces drying time but it also enhances the consumer acceptance of dehydrated pods, hence Experiment was conducted with the objective of standardization of pre-treatment for dehydration of okra.

Material and Methods
The present experiment was carried out at Post-harvest technology laboratory, College of Horticulture, Mudigere, Chikkamagalur during 2019-2020.

The experiment was laid out in Completely Randomised Design (CRD) with three replications in the experiment.

The okra (Arka Nikhita) pods were procured from KVK, Babbur farm, Hiriyur. The seeds of okra were sown at 45 cm × 30 cm spacing. The crop was raised by following the recommended package of practices of University of Horticultural Sciences, Bagalkot.

The pods which were collected from the field were thoroughly washed with the tap water then they were drained to remove excess moisture content. The pods were chopped by using sharp knife to uniform size of 1cm. These pieces were either subjected to brining (0.5 and 1.0%) or blanching (10 sec and 20 sec) or combination of both. Then the treated samples were drained to remove excess moisture content and weighed before dehydration. Dehydration of treated samples were done at constant temperature of 60 ^{0}C.

Observations were recorded on five randomly selected samples in each replication for different traits *viz.*, initial moisture content, final moisture content, drying time, dehydration ratio, rehydration ratio, crude fibre, chlorophyll content (Chlorophyll a, b and total chlorophyll) and scores of sensory evaluations.

Statistical analysis of data was done by using ANOVA on all experimental groups with three replications each. The data were analysed by using CRD design with 9 treatments of different pre-treatment. Calculation was done as suggested by Fisher (2007).

Results and Discussion

Effect of pre-treatment on initial moisture content, final moisture content and Drying time on dehydration of okra (Arka Nikhita harvested at 4 Days After Anthesis) is presented in the Table 1. The initial moisture content was recorded highest in T_2 (Blanching at 100 ^{0}C for 20sec) treatment. The moisture content of blanched okra samples increased slightly possibly due to absorption of water during blanching (Inyag and Ike, 1998). Whereas, brined okra recorded low moisture due to removal of moisture due to osmosis (Table 1).

Final moisture content of sample ranged from 10.02 to 10.15 per cent dry basis (d. b). The okra pods pre-treated with salt solution, drying time reduced compared to control and brining treatment. The reason of it is that the treatment with the higher NaCl (Salt) concentration resulted in the removal of substantial amount of moisture from the okra pods (Table 1).

Drying time varied significantly among different pre-treatments. Significantly maximum (12.24 hrs) drying time was recorded in T_9 (control) treatment followed by T_1 (Blanching at 100 ^{0}C for 10 sec) treatment (11.45 hrs). Whereas, the minimum (9.02 hrs) drying time was recorded at T_8 (Blanching at 100 ^{0}C for 20 sec + Brining solution at 1.00%) treatment (Table 1).

There is significant difference between treatments with respect to chlorophyll a, chlorophyll b and total chlorophyll content of pre-treated dehydrated okra fruits. The retention of chlorophyll content was recorded highest in control (T_9), followed by T_4 (Brining solution at 1.00%) treatment (9.14 mg/100g). Whereas, T_2 (Blanching at 100 ^{0}C for 20sec) treatment recorded lowest (1.27 mg/100g). Generally, blanched okra had low retention of chlorophyll content than that of brined and unblanched okra. This may be due to reason that after blanching degradation of chlorophylls was brought about by activity of enzymes and the low pH of the medium. In a study by Gębczyński (2003) [10] a significant 15 per cent decrease in chlorophyll content was brought about by blanching leaf blades of beet leaves (Table 2). The similar results are obtained by Dong *et al.* (2004) [6] and Kmiecik *et al.* (2008) [17].

Table 1: Effect of pre-treatment on initial moisture content, final moisture content and Drying time on dehydration of okra (Arka Nikhita harvested at 4 Days After Anthesis).

Treatment	Initial moisture (%)	Final moisture (%)	Drying time (hrs)
T_1 - Blanching at 100 ^{0}C for 10sec	90.17	10.05	11.45
T_2 - Blanching at 100 ^{0}C for 20sec	91.71	10.08	11.23
T_3 - Brining solution at 0.5% conc.	85.89	10.15	10.52
T_4 - Brining solution at 1.0% conc.	84.97	10.02	10.00
T_5 - T_1+ T_3 (Blanching at 100^{0}C for 10sec + Brining solution at 0.5% conc.)	87.31	10.19	9.34
T_6 - T_1+ T_4 (Blanching at 100^{0}C for 10sec + Brining solution at 1.0% conc.)	89.90	10.11	9.24
T_7 - T_2+ T_3 (Blanching at 100^{0}C for 10sec + Brining solution at 0.5% conc.)	88.31	10.04	9.15
T_8 - T_2+ T_4 (Blanching at 100^{0}C for 10sec + Brining solution at 1.0% conc.)	86.18	10.06	9.02
T_9 – Untreated	88.75	10.02	12.24
S.Em±	1.347	0.153	0.157
C.D. (P=0.01)	4.033	NS	0.471

The crude fiber content of unblanched and blanched okra was 22.24±0.153 and 25.9 per cent. This indicates that the blanching pre-treatment resulted in increase in crude fiber content. This might be due to the leaching of soluble solids during blanching which inturn result in decrease of total dry matter. Therefore, an increase in proportion of the crude fiber per unit dry matter has been observed in the blanched samples. Nilnakara *et al.* (2009) [24] also reported the loss of low molecular weight component such as minerals, sugar and vitamins from the plant cells to hot water during blanching; and decrease in the total solid thus led to the relative increase in the fiber content on dry basis during study on cabbage outer leaves (Table 3). Similar results were observed by Guida *et al.* (2013) [11], Kakade and Hatchan (2014) [16] and Tolera and Abera (2017) [35].

Table 2: Effect of pre-treatment on chlorophyll a, chlorophyll b and total chlorophyll content of dehydrated okra (Arka Nikhita harvested at 4 Days after Anthesis).

Treatment	Chlorophyll a (mg/100g)	Chlorophyll b (mg/100g)	Total chlorophyll (mg/100g)
T_1 - Blanching at 100^0C for 10sec	1.05	0.31	1.37
T_2 - Blanching at 100^0C for 20sec	0.98	0.28	1.27
T_3 - Brining solution at 0.5% conc.	5.25	1.97	7.25
T_4 - Brining solution at 1.0% conc.	6.33	2.12	8.45
T_5 - T_{1+} T_3 (Blanching at 100^0C for 10sec + Brining solution at 0.5% conc.)	1.08	0.44	1.52
T_6 - T_{1+} T_4 (Blanching at 100^0C for 10sec + Brining solution at 1.0% conc.)	0.89	0.45	1.34
T_7 - T_{2+} T_3 (Blanching at 100^0C for 10sec + Brining solution at 0.5% conc.)	1.12	0.36	1.48
T_8 - T_{2+} T_4 (Blanching at 100^0C for 10sec + Brining solution at 1.0% conc.)	1.22	0.41	1.65
T_9 – Untreated	7.02	2.24	9.26
S.Em±	0.021	0.015	0.036
C.D. (P=0.01)	0.062	0.046	0.108

The dehydration ratio was found to be maximum (15.16) at T_8 (Blanching at 100 ^{0}C for 20sec + Brining solution at 1.00%). While, the minimum (13.03) dehydration ratio was found to be at T_2 (Blanching at 100 ^{0}C for 10sec) (Table 3). The similar results were reported by Sharma (2011) [30], Wankade *et al.* (2013) [36], Kumar *et al.* (2014) [20], Hameed *et al.* (2016) [12] and Amir *et al.* (2017).

Table 3: Effect of pre-treatment on crude fibre, dehydration and rehydration ratio of dehydrated okra (Arka Nikhita harvested at 4 Days After Anthesis).

Treatment	Crude fibre (%)	Dehydration ratio	Rehydration ratio
T_1 - Blanching at 100 ^{0}C for 10sec	6.21	13.03	5.34
T_2 - Blanching at 100 ^{0}C for 20sec	6.54	13.28	5.77
T_3 - Brining solution at 0.5% conc.	5.85	14.02	3.68
T_4 - Brining solution at 1.0% conc.	5.22	13.61	3.31
T_5 - T_{1+} T_3 (Blanching at 100^0C for 10sec + Brining solution at 0.5% conc.)	5.74	13.34	4.06
T_6 - T_{1+} T_4 (Blanching at 100^0C for 10sec + Brining solution at 1.0% conc.)	5.13	14.41	4.18
T_7 - T_{2+} T_3 (Blanching at 100^0C for 10sec + Brining solution at 0.5% conc.)	4.18	13.92	4.27
T_8 - T_{2+} T_4 (Blanching at 100^0C for 10sec + Brining solution at 1.0% conc.)	4.90	15.16	4.14
T_9 – Untreated	3.21	13.85	5.27
S.Em±	0.068	0.212	0.077
C.D. (P=0.01)	0.207	0.634	0.230

Significantly highest rehydration ratio (5.77) was recorded at T_2 (Blanching at 100^0C for 20sec). while the lowest rehydration ratio (3.31) was observed at T_4 (Brining solution at 1.00%). The extent of products rehydrates following drying is dependent on structural and chemical that occurs within the products. Generally, rehydration ratios were in the following order: blanched treated> control >brine-treated. According to Jayaraman *et al.*, (1990) [14] irreversible cellular rapture results in reduced hydrophilic properties which are reflected in the inability of tissues to rehydrate fully as observed in this study. Osmotic treatment followed by air-drying has been reported by Taiwo *et al.* (2002) [34] to significantly reduce mass transfer co-efficient during rehydration. This observation could be due to extent of cellular and structural disruption caused by the heat treatment or immersion in brine (Krokida and Kouris, 2003) [19]. Brine-treated samples had the lowest uptake of water, compared to the other samples, over the rehydration period (Table 3). This is similar to reduced rehydration behaviors for brine treated products reported by Debnath *et al.* (2004) [7] and Marabi *et al.* (2004) [21]. This is similar to observation reported by Sagar and Kumar (2010) [31].

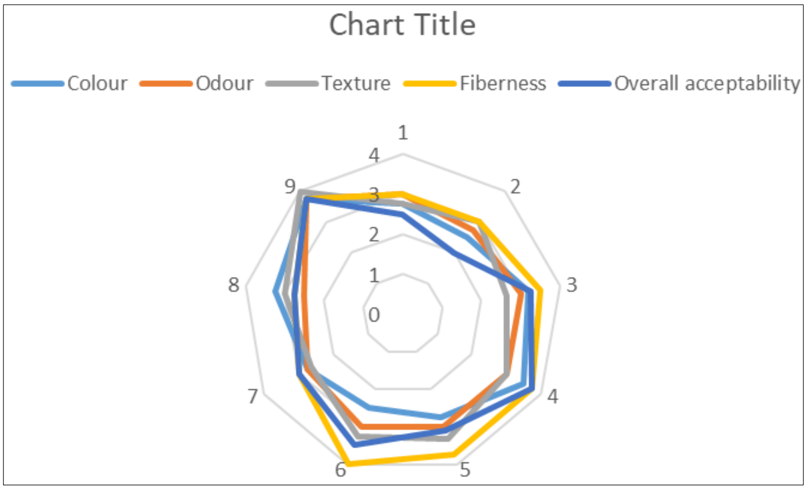

Fig 1: Effect of pre-treatment on sensory evaluation of dehydrated okra (Arka Nikhita harvested at 4 days after anthesis)

Sensory characters of pre-treated okra pods were evaluated. Okra pods pre-treated with brining solution of 1.00 per cent concentration received higher ratings than other pre-treatments. Okra pods pre-treated with blanching received lower rating. Colour of fresh okra was significantly better than pre-treated with Brining solution of 1.00 per cent. Expectedly, the aroma of the fresh okra pods was significantly better than pre-treated okra. Brined okra sample received higher ratings compared to blanched okra pods. Poor ratings of blanched okra could be due to loss of volatile aroma components during blanching and prolonged exposure to air during drying. The taste of brined okra was rated close to fresh okra. About 90 per cent of the panellists preferred the fresh okra than pre-treated okra (Fig.1). Similar findings were reported by Stone *et al.* (2008), Falade *et al.* (2010) [8], Sra *et al*. (2011) [32] in carrot and Santos *et al.* (2019) [29].

Conclusion

Sensory evaluation of food product is an important criterion by which consumer acceptability can be assessed. The sensory evaluation test on the 8 samples along with fresh okra showed significant difference between the pre-treatments, the sample pre-treated with salt concentration (Brining) of 1.00 per cent appeared better when compared to all other samples. The physico-chemical properties were also found be better in okra pre-treated with brining solution of 1.00 per cent which is preferred over other pre-treatments.

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