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MICROBIAL AND ORGANOLEPTIC EVALUATION OF DEHYDRATED FIG FRUIT (*FICUS CARICA* L.) CV. BROWN TURKEY USING DIFFERENT DRYERS AND GEOMETRY

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ABSTRACT

Fig (*Ficus carica* L.) considered as a minor fruit crop in India. Being highly perishable, fig fruit cannot be kept for longer period at ambient condition. Fig fruit after drying stored for about six to eight months. Hence, there is great scope and need for drying of fig fruits with suitable dryer and geometry along with microbial and organoleptic evaluation. Among different drying methods used for dehydration of fig fruit, dehumidified air dryer found better in terms of less microbial load and organoleptic evaluation as compared to tray drying and solar drying with more organoleptic scores. Whereas, among different geometry used for dehydration of fig fruit, longitudinal quarters found better in terms of organoleptic scores as compare to whole fruit, pricked whole fruit with more organoleptic scores and whole fruit found best with less microbial load.

***Key words*: fig, drying, microbial evaluation and organoleptic evaluation.**

Introduction

An important challenge to ensure food security in most of the developing countries is making food available all year round. Most of the horticultural products are perishable and are abundant in a particular season but absent in another seasons (Habou *et al.*, 2003). Horticultural products tend to become scarce in other seasons making food preservation an important activity in households and communities. Both fresh and processed food make up vital parts of the food supply chain. Processed food contributes to both food securities which means sufficient food is available and nutritional security ensuring that food quality meets human nutrient needs.

Fig fruit is consumed as fresh, dried, preserved, canned, and candied forms. Fresh and dried fig fruits are especially rich in fiber, trace minerals, antioxidant, polyphenols, proteins, sugars, organic acids and volatile compounds that provide a pleasant characteristic aroma. (Olivera *et al.*, 2010). The soft and fleshy nature of the fruit makes it more susceptible to injuries increasing losses due to spoilage. Thus, the fruit has a limited shelf life and named as "under- utilized crop" being highly perishable, fig fruits cannot be stored for longer period at ambient condition and cold storage (7-14 days) but the dried figs can be stored for 6 to 8 months (Venkataratnam, 1988).

There is an increasing market demand for dehydrated fruits and vegetables worldwide (Zhang *et al.*, 2006). Several industrial processes have been developed for their preservation. Among them, drying is one of the common methods, easily accessible and most widespread food processing technology (Jairaj *et al.*, 2009), as water removal inhibits microorganism's growth and enzyme activity (Perussello *et al.*, 2012). Thus, it helps to prevent spoilage in dried food (Boyer, 2008). Drying decreases the weight of the product, simplifying in its transport and storage. Dried foods should have water content lower than 25 g/100 g and water activity lower than 0.6 (De Bruijn *et al.*, 2016).

Farmers are forced to sell fresh fruits which often cause loss to them due to highly perishable nature of the fruit. In fact, cold storage of fresh figs is a challenge in rural areas. Hence, there is a great scope and need for drying of fig to produce dried fig with optimum quality in order to avoid wastage and economic loss to farmers, stabilize the prices, protect the nutrients and encourage fig fruit cultivation, the surplus fig produced needs to be processed and preserved properly.

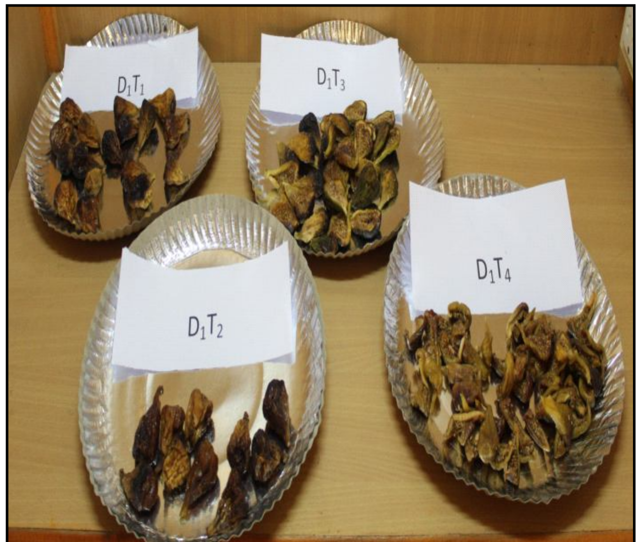
This study focused on drying by employing different dryers and imposing pre-drying treatments to fig fruit as whole fruit, pricked whole fig, halves and quarters in osmotic agent and standardize the best dryer and best geometry of fig with respect to physical and chemical parameters and microbial and sensory evaluation.

Material and Methods

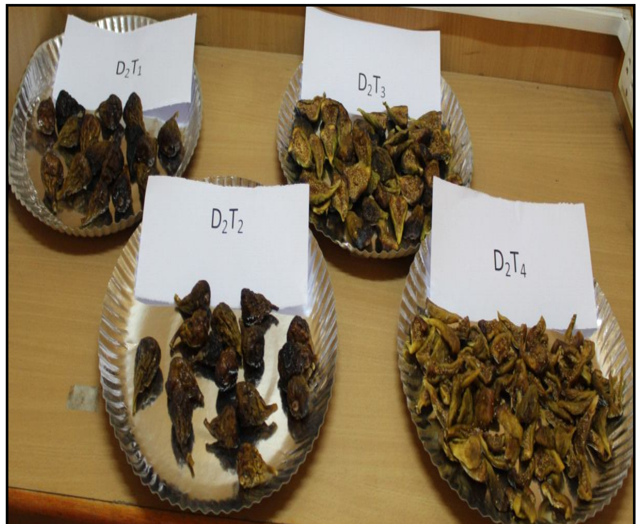
An experiment consisting of thirty six kg fresh fig dehydration including three replications one kg per treatment sample size and experimental design factorial completely randomized design, with was carried out in the Department of Processing and Food Engineering, College of Agricultural Engineering, UAS, Raichur. Trial divided into two factors namely types of dryer which was sub divided into D_1: Solar dryer, D_2: Mechanical dryer (tray dryer), D_3: Dehumidified air dryer and second factor geometry of the fruit which was sub divided into G_1: Whole, G_2: Whole Pricked, G_3: Two halves, G_4: Quarter. Fresh fig fruits (cv. Brown Turkey) used in the present investigation were procured from a well maintained fig orchard owned by Anand Reddy a progressive farmer of Shantinagar Village, district Karnool, Andra Pradesh. Bruised and injured fruits were discarded and sound fruits were selected.

Fig fruits harvested at optimum maturity were brought to the Department of Horticulture. Then the fruits were thoroughly washed in clean water. Fruits were tied in muslin cloth and placed in boiling water at a temperature ranging 90-95°C for 4 minutes (Bharatkumar *et al.*, 2018) Syrup was prepared by mixing known quantity of sugar in gentle boiling water to get a final total soluble solid content of 40 °Brix (Bharatkumar *et al.*, 2018). After blanching, whole fig fruits were pricked (18-20 holes) with help of syringe (G_2), cut longitudinally into halves (G_3) and both longitudinally to make quarter pieces (G_4) using stainless steel knife. After preparation, fruits were steeped in sugar syrup (40 ÚBrix) containing 0.2 per cent KMS and 0.25 per cent citric acid for 24 hours. Pre-treated fruits were dried in different dryers namely solar drying, tray dryer and dehumidified air dryer at a temperature of 45°C till reaching a safe moisture level of 17-20 per cent. The time required for drying in different pretreatments to reach the safe and optimum moisture level was recorded in hours.

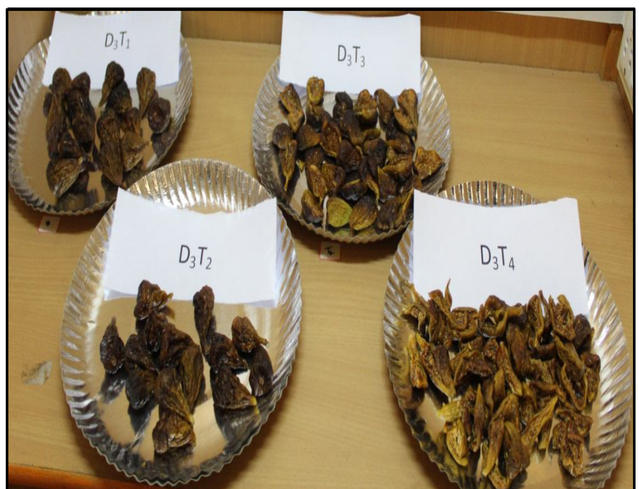
Small pieces of two gram of fig fruits were cut with



Solar Dryer



Tray Dryer



Dehumidified air Dryer

Plate 1. Dehydrated figs of different geometries dried in different dryers.

Table 1: Fungi (10^{-3} cfu/g) of dehydrated fig fruits as influenced by drying techniques and different fruit geometry.

Dryer Geometry	D_1	D_2	D_3	Mean
G_1	1.33	1.00	0.33	**0.88**
G_2	2.00	1.33	0.66	**1.33**
G_3	2.33	1.66	1.00	**1.66**
G_4	2.66	2.00	1.66	**2.10**
Mean	**2.08**	**1.49**	**0.91**	**1.49**
For comparing the means	**S. Em.±**		**CD at 1%**	
Drying methods (D)	0.008		0.03	
Different geometry (G)	0.009		0.03	
Interactions (D×G)	0.016		0.06	

Initial value of fresh fruit = 1×10^{-2} cfu/g
D_1: Solar dryer, D_2: Mechanical dryer (tray dryer), D_3: Dehumidified air dryer, G_1: Whole, G_2: Whole pricked, G_3: Two halves, G_4: Quarter.

help of sterile surgical blade and ground by adding 10 mL of distil water with sterilized pistil and mortar then made serial dilution in labelled test tubes. Plate count agar and rose Bengal agar nutrient media for bacteria and fungi respectively were used. The colonies were counted after the incubation period and the number of cfu per mL of sample were calculated by applying the following formula (Nirmala, 2016).

$$\text{Cfu/mL} = \frac{\text{Mean number of cfu} \times \text{Dilution factor}}{\text{Volume of sample}}$$

Sensory evaluation of dehydrated fig fruit was carried out by a semi trained panel consisting of Teachers and Post-Graduate students of College of Agriculture, Raichur with the help of nine point hedonic rating scale (1 = dislike extremely, 2 = like only slightly, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much and 9 = like extremely) for colour and appearance, texture, taste, flavour and overall acceptability (Swaminathan, 1974).

Table 2: Bacteria (10^{-5} cfu/g) of dehydrated fig fruits as influenced by drying techniques and different fruit geometry.

Dryer Geometry	D_1	D_2	D_3	Mean
G_1	6.00	4.33	2.33	**4.22**
G_2	6.33	4.66	3.33	**4.77**
G_3	6.66	5.33	3.66	**5.22**
G_4	7.00	5.66	4.33	**5.66**
Mean	**6.50**	**4.99**	**3.41**	**4.97**
For comparing the means	**S. Em.±**		**CD at 1%**	
Drying methods (D)	0.005		0.14	
Different geometry (G)	0.005		0.16	
Interactions (D×G)	0.09		0.28	

Initial value of fresh fruit = 1×10^{-2} cfu/g
D_1: Solar dryer, D_2: Mechanical dryer (tray dryer), D_3: Dehumidified air dryer, G_1: Whole, G_2: Whole pricked, G_3: Two halves, G_4: Quarter.

Table 3: Organoleptic evaluation of dehydrated fig fruits as influenced by drying techniques and different fruit geometry.

Organoleptic evaluation						
Tr	**ACA**	**AT**	**AF**	**AFN**	**AA**	**AOA**
D_1G_1	6.70	6.29	6.81	6.76	6.85	6.80
D_1G_2	6.71	6.83	6.69	6.73	6.79	6.75
D_1G_3	6.87	7.23	6.97	7.24	7.09	7.08
D_1G_4	7.09	6.87	7.30	6.79	6.88	6.98
D_2G_1	6.37	6.41	6.48	6.46	6.66	6.47
D_2G_2	6.87	6.93	6.70	6.58	6.58	6.73
D_2G_3	6.90	6.84	7.00	7.08	7.05	6.97
D_2G_4	7.27	7.25	7.11	7.01	7.17	7.16
D_3G_1	7.07	7.06	7.07	6.74	6.81	6.95
D_3G_2	7.11	7.58	6.86	6.63	6.72	6.98
D_3G_3	7.36	7.24	7.36	6.78	7.19	7.18
D_3G_4	7.77	7.43	7.36	6.90	7.98	7.28

Tr: Treatments; ACA: Average colour and appearance; AT: Average taste; AF: Average flavour; AFN: Average firmness; AA: Average aroma; AOA: Average overall acceptability

Result and Discussion

Microbial analysis

The data pertaining to total plate count of fungi (10^{-3} cfu/g) and total plate count of bacteria (10^{-5} cfu/g) of dried fig as influenced by different geometry and drying methods and interaction effect is presented in Table 1 and Table 2 respectively. Among them whole fruit geometry found to contain significantly least total plate count of fungi G_1 (0.88) followed by G_2 (1.33) and maximum total plate count of fungi was noticed in G_4 (2.10). Among different dryers significantly maximum total plate count of fungi was found in D_1 (2.08), whereas significantly least total plate count of fungi of dried figs was observed in D_3 (0.91).

Total plate count of bacteria for dried fig with different geometry, drying methods and interactions varied significantly. Among them whole fruit geometry found to contain least total plate count of bacteria G_1 (4.22) followed by G_2 (4.77) and maximum was noticed in G_4 (5.66). Among different dryers significantly maximum total plate count of bacteria was found in D_1 (6.50), whereas, significantly least total plate count of bacteria of dried figs was observed in D_3 (3.41)

Foods, such as fruits and vegetables are sliced to increase surface-area to volume ratio for faster removal of moisture during drying. (Victor *et al.*, 2017). In the present study, lower fungal count was observed. This might be due to addition of 0.1 per cent KMS preservative, which inhibits the growth of microorganisms during drying. According to Prevention of Food Adulteration (PFA) rules (1956), limit for microbial load in dehydrated fruits is not more than 40,000 per g., numerically maximum fungal count (2.10 cfu/g) and bacterial count (5.66 cfu/g) was recorded in G_4. This is might be due to more surface area in G_4 (longitudinally cut in to four pieces) and also might be due to decreased effectiveness in preservative action of KMS with passage of time.

The results of fungal and bacterial count indicates all four geometry of dehydrated fig had minimum microbial load among different geometry of fig fruit G_4 was noticed with more microbial load which was due to more surface area as compare to G_3 G_2 and G_1 while in different dryers less microbial load was noticed in dehumidified air dryer which was due to controlled relative humidity but in tray dryer and solar dryer humidity was not controlled this also can be linked with drying time as more the time more chances of increase in microbial load so total plate count for fungi and bacteria was more in case of solar dryer. Results are in agreement with data obtained by Naikwadi *et al.*, (2010) and Manjunath *et al.*, (2019) in fig fruit.

Organoleptic evaluation

Organoleptic scores obtained for dehydrated figs as influenced by different geometry and drying methods and their interaction are presented in Table 3. quality is the endmost criterion of the desirability of any food product to the consumer. Overall quality depends on nutrition, quantity, sensory quality and other hidden attributes. Sensory quality is a combination of different senses of perception coming in to play in choosing and eating a food. This parameter is of great importance to both the processor and consumer (Ranganna, 1995). Sensory scores for colour and appearance, flavour, taste, texture and overall acceptability of dehydrated figs in the present study showed significant differences among the treatments. Maximum score for colour and appearance D_3G_4 (7.77), taste D_3G_2 (7.58), D_3G_4 and D_3G_3 flavour (7.36), firmness D_1G_3 (7.24), aroma D_3G_4 (7.98) and overall acceptability D_3G_4 (7.28) was noticed.

This might be due to sensorially favorable qualities of figs attained in this geometry G_4 viz., higher solid gain (22.55%), TSS (22.62 ÚBrix), minimum titratable acidity (0.126%), and more light colour as indicated by *L** value. On the other hand, G_2 (Whole pricked fig) recorded minimum scores for colour and appearance, flavour, taste, texture and overall acceptability. Pricking had reduced the aesthetic appearance of the dehydrated fig leading to minimum score for colour and appearance in G_2, besides affecting texture, taste and flavour undesirably. The treatments G_1 and G_2 did not differ significantly for most of the sensory attributes. Longer duration of time taken for drying in figs of these two treatments were more brown thus affecting first visual appeal. Variations in sensory properties owing to the influence of treatments have been reported by Satwadhar *et al.*, (2010), Kant *et al.*, (2011) and Anushree (2017) in figs.

The method of drying also had significant effect on the organoleptic characters of dehydrated fig fruits. Dehumidified air dryer was found to be superior to solar drying and tray drying with respect to different organoleptic characters. The organoleptic scores for colour and appearance, taste and overall acceptability were much higher in dehumidified air dryer as compared to tray drying and solar drying. The higher scores given to colour and appearance, texture, taste, flavour and overall acceptability for a product dried in dehumidified air dryer may be attributed to the uniform temperature of drying and shorter period of drying, better removal of moisture leading to crisp texture as compared to tray drying and solar drying. Similar results of superiority of electric drying over solar drying with respect to organoleptic quality has been reported by Teotia *et al.*, (1976), Mehta *et al.*, (1982) and Pawar (1989) in fig fruit.

Conclusion

Among different drying methods used for dehydration of fig fruit, dehumidified air dryer found better in terms of less microbial load and organoleptic evaluation as compare to tray drying and solar drying with more organoleptic scores. Whereas, among different geometry used for dehydration of fig fruit, G_4- longitudinal quarters found better in terms of organoleptic scores as compare to G_1-whole fruit, G_2-pricked whole fruit with more organoleptic scores and G_{1-}whole fruit found best with less microbial load.

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