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Impact of Blanching and Drying Methods on Quality Attributes of Byadgi Chilli

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ABSTRACT: The purpose of the study was undertaken to evaluate the effects of blanching and drying methods on quality attributes of chilli. The fresh red chilli samples were blanched at the temperature of 90 °C for duration of 3 minutes then exposed to different drying methods. The study revealed that CAZRI drier had no aflatoxin contamination and had highest colour values (*L*, a*, b), ascorbic acid, capsaicin and capsanthin retention. Notably, the application of pre-drying blanching treatment not only accelerated the drying process but also contributed to the preservation of colour values in the dried chilli and attained less moisture, had low water activity was noticed in blanched red chilli, dried in solar tunnel drier.**

Keywords: Blanching, drying, chilli.

INTRODUCTION

Chilli, scientifically known as *Capsicum annuum* L., has a rich history and global appeal. Originating in South America, they now thrive across the world. Due to its widespread appeal, chilli is often referred to as the "Wonder Spice" (Sowjanya *et al*., 2017). India cultivates chilli under diverse agroclimatic conditions, encompassing tropical, subtropical and temperate regions (Hazra *et al*., 2011). Chilli is a versatile crop with more than 400 different varieties grown worldwide. Major chilli-producing countries include India, China, Indonesia, Korea, Pakistan, Egypt, Mexico, the United States, Italy and Hungary (Kumar *et al*., 2017). India, being the top producer and exporter, cultivated over 1 million MT of chilli in 2018. The primary chilli-producing states in India are Telangana, Karnataka, Madhya Pradesh, Orissa, Gujarat, Assam, Punjab, Rajasthan, Uttar Pradesh, and Mizoram.

It is a rich source of vitamins, minerals, fiber and ascorbic acid. Chilli spoils quickly a few days after harvest due to the high humidity. The most common method of preserving chilli is drying, which is an energy-intensive process. The main purpose of drying is to reduce the moisture content to a level that allows safe storage for longer periods, thereby increasing shelf life (Ajaykumar *et al.*, 2012). The primary goal of this research is to analyze the effects of blanching and drying methods on the quality properties of Byadgi chilli.

MATERIAL AND METHODS

A. Red ripe chilli

Freshly harvested ripened Byadgi kaddi chilli was procured from the field of a progressive farmer of Bagalkote.

B. Solar tunnel drier

The structure consisted of a cylindrical metallic frame of size 30 × 15 × 10 feet covered with UV stabilized transparent polythene sheet of 200-micron thickness. The structure is positioned in the N-S direction, with a door on the south wall. The two exhaust fans located on the front and backside of the tunnel assist to remove the moist air from the structure with a chimney on the top. The product intended for drying was uniformly spread on stainless steel trays (80 × 60 × 5 cm) which were kept on the metallic mesh stand inside the tunnel (Pooja, 2018).

C. Fruit and vegetable drier (CAZRI, Jodhpur)

Red ripe chilli after pre-treatment (hot water blanching at 90°C for 3 min) were spread on stainless steel trays and kept in a solar drier (cum electric drier) at an average temperature of 48°C, developed by Institute Technology Management Unit, Central Arid Zone Research Institute (CAZRI), Jodhpur used for dehydration of fruits and vegetables (Anand, 2017).

D. Sun drying

In open sun drying, method red ripe chillies were spread in a thin layer exposed to the sun. They were turned over at intervals to have uniformly dried slices. (Kumar and Tiwari 2007).

E. Moisture content (%)

The moisture content of fresh and dried chillies was determined using a Radwag moisture analyzer (Model: MAC 50, Make Poland). Two grams of fresh and dried chilli sample was placed in the sample dish. The moisture analyzer indicated the endpoint of measurement by a beep sound and the resultant constant value for moisture was recorded and drying rate were calculated as follows:

$$D = \frac{(M_1 - M_2)}{(T_2 - T_1)}$$

Where, D = Drying rate (% wb), M1 = Moisture content (% wb) at Time T1 (Day) and M2 = Moisture content at Time T2 (day).

F. Water activity (a_w)

The water activity of chilli sample was determined by a water activity meter (Labswift-aw Novasina). Small pieces of the sample was filled into sample holder up to the mark indicated and then placed inside the water activity meter, so that the sample wouldn't touch the sensor present in the lid. The endpoint was indicated by three beep sounds and the instrument gives constant value for water activity.

G. Colour of the chilli (L, a*, b*)*

Colour of the chilli pod was measured using Colour Flex EZ colorimeter (Model: CFEZ 1919, Hunter associates laboratory. Inc., Reston) fitted with 45 mm diameter aperture. The instrument was calibrated using black and white tiles provided. Colour was expressed in terms of *L** (lightness/darkness), *a** (redness/greenness) and *b** (yellowness/blueness).

H. Ascorbic acid content

Ascorbic acid was estimated by volumetric method. Exactly 5 ml of the working standard solution was pipetted into a 100 ml conical flask, to this 10 ml of 4 per cent oxalic acid was added and this was turned to pink colour end point when titrated against the dye solution. The amount of the dye consumed was equivalent to the amount of ascorbic acid. One gram chilli sample was weighed and crushed using 4% oxalic acid. The extract was filtered through Whatman No. 41 filter paper and made the volume up to 100 ml. Five ml of the extract was pipetted out into conical flask, 10 ml of 4% oxalic acid was added and was titrated against the dye. The amount of ascorbic acid present in the sample was calculated using the following formula.

$$\text{Ascorbic acid content (mg100)} = \frac{\text{Titrate value} \times \text{dye factor} \times \text{vol. up made} \times 100}{\text{Weight sample} \times \text{vol. of sample taken}}$$

I. Capsanthin (ASTA units)

Extractable colour value in dry chilli fruits was determined by measuring the absorbance of acetone extract of ground chilli fruit at 450 nm. Fifty milligram of chilli powder was extracted with 50 ml of pure acetone. This solution was kept for 16 hours at room temperature in dark area. Pure acetone was taken as blank.

To calculate the colour value, the absorbance of standard potassium dichromate ($K_2Cr_2O_7$) solution at 450 nm is taken. The standard $K_2Cr_2O_7$ solution is prepared by dissolving 50 mg in 100 ml of distilled water. The colour value is determined by using following formula:

$$\text{Capsanthin (ASTA units)} = \frac{\text{O.D of sample} \times 200}{\text{Mg/ml of sample} \times \text{O.D of standard solution} \times 2}$$

J. Capsaicin content (%)

Capsaicin in dried chilli samples was determined using the procedure described by Palacio (1977) as described below:

The dried chilli (2 g) was ground and passed through the No. 40 sieve (0.42 mm) and placed in 100 ml volumetric flask. The sample was diluted to volume with ethyl acetate and kept for 24 hours for extraction. Further, the concentrated extract was diluted with ethyl acetate (1:5) prior to observation recordance. Later, the 0.5 ml of Vanadium oxytrichloride ($VoCl_3$) solution (0.5 % $VoCl_3$ in ethyl acetate) was added and mixed gently. The absorbance was taken at 720 nm and subtracted the reading of 0.5 ml Vanadium oxytrichloride added to ethyl acetate and compared with standard curve prepared from pure capsaicin.

$$\text{Capsaicin (\%)} = \frac{\text{mg capsacian} \times 100 \times 200}{1000 \times 100 \times 12}$$

K. Aflatoxin B1 content (µg/kg)

The aflatoxin B1 content in chilli was measured by indirect competitive ELISA method at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad.

RESULTS AND DISCUSSION

A. Moisture (%)

Moisture content of chilli varied among the treatments, the T_3 (Blanching + solar tunnel drier) exhibited lower (7.20 %) moisture content in the chilli (Table 1). This significant reduction in moisture could potentially be attributed to the rupturing of the chilli membranes during the blanching process. The blanching treatment may have caused the membranes of the chilli to rupture, making them more tender and facilitating faster removal of moisture. As a result, the chilli dried more quickly, leading to lower moisture content.

Furthermore, the use of a solar tunnel drier contributed to the reduced moisture levels in the T_3 treatment. The air temperature inside the solar tunnel was notably higher than the ambient temperature, creating a favourable environment for moisture evaporation. The elevated air temperature inside the solar tunnel accelerated the drying process, resulting in lower moisture content in the chilli. This was in conformity with the work of Tavakplipour and Mokhtarian (2015), Jyothi *et al*. (2008); Wiriya *et al*. (2009); Kyung *et al*. (2012).

Whereas, T_2 (without blanching + open sun drying) treatment, exhibited the highest (8.21 %) moisture content among the observed samples. This outcome can be attributed to the exposure of the chilli to ambient conditions, encompassing fluctuations in both humidity and temperature.

Table 1: Effect of blanching and drying methods on moisture content (%) of fresh red chilli.

Treatments	Moisture (%)					Mean
	Drying period (Days)					
	Initial	2^{nd} day	4^{th} day	6^{th} day	8^{th} day	
T_1 - Blanching + open sun drying	84.21	46.33^{ab}	28.45^{b}	16.22^{c}	8.17^{a}	**36.68**
T_2 - Without blanching + open sun drying	84.94	51.00^{a}	36.04^{a}	21.27^{a}	8.21^{a}	**40.29**
T_3 - Blanching + solar tunnel drier	83.96	36.25^{c}	15.46^{d}	7.20^{e}	7.20^{c}	**30.01**
T_4 - Without blanching + solar tunnel drier	84.70	42.35^{b}	23.48^{c}	14.68^{d}	7.44^{b}	**34.53**
T_5 - Blanching + CAZRI drier	84.03	40.56^{bc}	22.46^{c}	13.82^{d}	7.66^{b}	**33.71**
T_6 - Without blanching + CAZRI drier	84.53	48.48^{a}	30.22^{b}	18.23^{b}	7.97^{ab}	**37.89**
Mean	**84.40**	**44.16**	**26.02**	**15.24**	**7.78**	
S.Em±	1.196	1.175	0.561	0.391	0.084	
CD @ 1%	**NS**	**4.784**	**2.282**	**1.592**	**0.341**	

Value indicates mean of four replicates.
Different letters in the same column indicate significant differences at $P \leq 0.01$ (Duncan's multiple range test)

Table 2: Effect of blanching and drying methods on drying rate (%) of fresh red chilli.

Treatments	Drying rate (%)				Mean
	Drying period (Days)				
	2^{nd} day	4^{th} day	6^{th} day	8^{th} day	
T_1 - Blanching + open sun drying	37.88^{c}	17.88^{b}	12.23^{b}	8.05^{c}	**19.01**
T_2 - Without blanching +open sun drying	33.94^{d}	14.96^{c}	14.77^{a}	13.06^{a}	**19.18**
T_3 - Blanching + solar tunnel drier	47.71^{a}	20.79^{a}	8.26^{d}	7.20^{c}	**20.99**
T_4 - Without blanching + solar tunnel drier	42.35^{b}	18.87^{b}	8.80^{d}	7.24^{cd}	**19.32**
T_5 - Blanching + CAZRI drier	43.47^{b}	18.10^{b}	8.64^{d}	6.16^{d}	**19.09**
T_6 - Without blanching + CAZRI drier	36.05^{cd}	18.26^{b}	10.78^{c}	10.26^{b}	**18.84**
Mean	**40.23**	**18.14**	**10.78**	**8.66**	
S.Em±	0.621	0.335	0.275	0.277	
CD @ 1%	**2.526**	**1.364**	**1.121**	**1.127**	

Value indicates mean of four replicates.
Different letters in the same column indicate significant differences at $P \leq 0.01$ (Duncan's multiple range te

B. Drying rate (%)

In the present experiment the higher drying rate was observed in T_3 (Blanching + solar tunnel drier) (20.99 %) (Table 2). This can be attributed to two factors. Firstly, the blanching pre-treatment removes the wax layer on the surface of the chilli, facilitating the diffusion of water from the surface and consequently increasing the drying rate. This finding is consistent with previous studies by Jyothi *et al*. (2008), Wiriya *et al*. (2009) and Kyung *et al*. (2012). Secondly, the solar tunnel drier elevated the temperature inside, which further contributed to the accelerated drying rate.

The lower drying rate was observed in T_6 (Without blanching + CAZRI drier) (18.84 %) it may be due to wax layer on the surface of chilli, which hindered the diffusion of water and impeded the drying process and CAZRI drier exposed the chilli to less favourable drying condition, including lower temperature, high humidity and inadequate airflow. These suboptimal conditions slowed down the evaporation of moisture from chilli, leading to a lower drying rate.

C. Water activity (a_w)

Water activity (a_w) is a significant concern in relation to the chemical stability of dry food products (Sunyoto and Futiawati 2012). In the study lower water activity of chilli noticed in the in T_3 (Blanching + solar tunnel drier) (0.63) (Fig. 1). This may possibly be due to Blanching, followed by drying in a solar tunnel drier, can facilitate more efficient moisture removal from the chilli samples. Blanching partially removes moisture from the surface of the chilli, and subsequent drying in a solar tunnel drier can further dehydrate the samples. The combined effect of blanching and drying may result in a more pronounced reduction in water content, leading to lower water activity. Further it is also evident from previous finding Reis, *et al.* (2008) blanched potato stick had lower water activity compared to unblanched.

D. Lightness (L) value*

As the drying time increased, the *L** value of all chilli samples decreased, which caused the changes in reddish colour of chilli to dark-brown colour. Among the treatments, T_5 (Blanching + CAZRI drier) (20.77) had highest lightness value whereas, lowest lightness value was recorded in T_2 (Without blanching + open sun drying) (17.58) (Fig. 2). This indicates that sun-dried sample exhibited the most pronounced colour change, while the CAZRI drier showed the least impact. This difference can be attributed to the gradual growth of microorganisms during sun-drying, as the temperature increases slowly. This microbial growth leads to a progressive decrease in capsaicinoids content and subsequently reduces the antimicrobial activity against *Bacillus subtilis*, *Bacillus cereus*, and *Sarcina lutea* (Kennao *et al*., 2020).

E. Redness (a) value*

The *a** value, indicating the redness of chilli. The drying process resulted in a reduction of the *a** value, indicating a decrease in redness. Moreover, as the drying temperature increased, the degree of redness loss intensified, primarily due to the degradation of capsaicinoids, specifically capsorubin and capsanthin (Ghosh *et al*., 2007). These compounds are responsible for the vibrant red colour of chilli. The maximum *a** value was noticed in the T_5 (Blanching + CAZRI drier) (19.29) and minimum *a** value was noticed in the T_2 (Without blanching + open sun drying) (13.56) (Fig. 3). This might be due to because of oxidation and decomposition of pigment during fast vaporization on the surface of chilli at elevated temperatures.

F. Yellowness (b) value*

The results indicate that the yellowness value decreased gradually with drying time regardless of the blanching and drying method used. At the beginning of the drying period, the highest (22.51) yellowness value was T_1 (Blanching + open sun drying) and lowest (16.32) value was observed in T_2 (Without blanching + open sun drying) (Fig. 4). It is mainly due to degradation of pigment. This results were agreement with previous studies Saengrayap *et al*. (2016); Gupta *et al*. (2018); Krithika *et al*. (2014); Jalgaonkar, K. (2017).

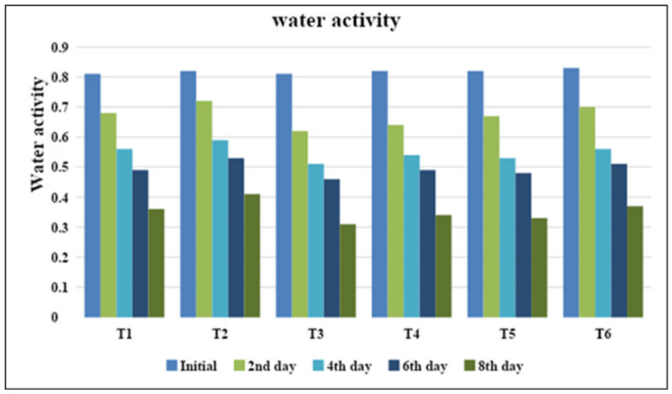
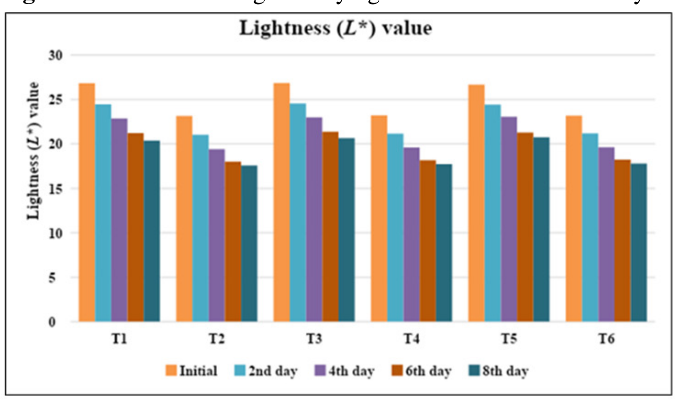


Fig. 1. Effect of blanching and drying methods on water activity content of fresh red chilli.



T_1 - Blanching + open sun drying, T_2 - Without blanching + open sun drying, T_3 - Blanching + solar tunnel drier, T_4 - Without blanching + solar tunnel drier, T_5 - Blanching + CAZRI drier, T_6 - Without blanching + CAZRI drier

Fig. 2. Effect of blanching and drying methods on lightness values of fresh red chilli.

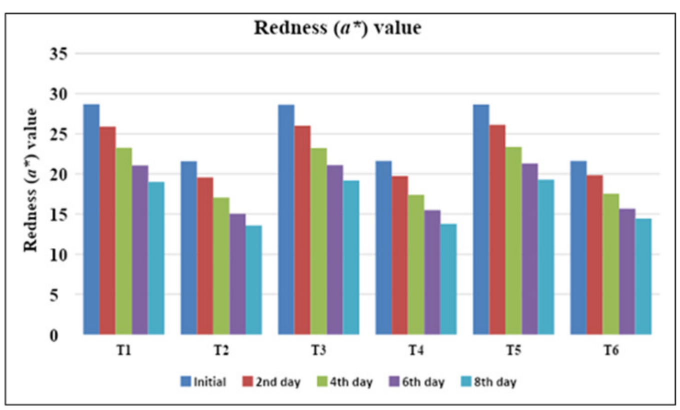
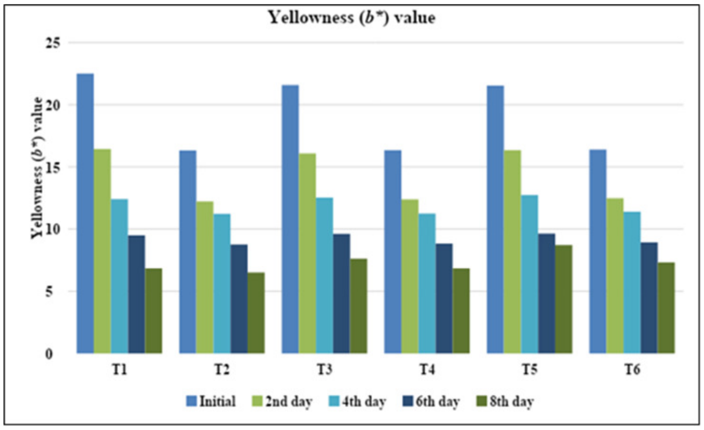


Fig. 3. Effect of blanching and drying methods on redness values of fresh red chilli.



T_1 – Blanching + open sun drying, T_2 – Without blanching +open sun drying, T_3 – Blanching + solar tunnel drier, T_4 – Without blanching + solar tunnel drier, T_5 – Blanching + CAZRI drier, T_6 – Without blanching + CAZRI drier

Fig. 4. Effect of blanching and drying methods on yellowness values of fresh red chilli.

G. Ascorbic acid (mg/100g)

The ascorbic acid content of chilli decreased upon drying time. Among treatment T_6 (Without blanching + CAZRI drier) exhibited the highest retention of ascorbic acid (112.93 mg/100g) (Fig. 5). It is due to CAZRI drier is a controlled drying environment that might have reduced the exposure of the chilli to heat, light, and oxygen, all of which can contribute to the less degradation of ascorbic acid. On other hand, treatment T_1 (Blanching + open sun drying), resulted in the lowest retention of ascorbic acid (88.14 mg/100g), which might have occured due to blanching treatment led to the vitamin loss as vitamin C, being water soluble and oxidation due to longer period of drying especially open sun drying and ascorbic acid was oxidized by the light and high temperature during drying leading to the formation of L-dehydroascorbic acid and a wide variety of carbonyl and other unsaturated compounds (Famurewa, *et al*., 2006). This was in agreement with the work of Shittu *et al*. (1999) who reported that the drying of vegetables, led to some losses of ascorbic acid and some sensory characteristics. Howard *et al*. (1994) reported that 75% of ascorbic acid in red chilli was lost during drying. Similar results have been reported by Pura *et al*. (2001); Ou *et al*. (2002); Marin *et al*. (2004); Sidonia *et al*. (2005); Suna *et al*. (2006).

H. Capsaicin (%)

The capsaicin of chilli showed a significant difference between the treatments. The mean capsaicin was 0.088%. Significantly highest (0.108%) capsaicin was recorded in T_6 (Without blanching + CAZRI drier) While, T_1 (Blanching + open sun drying) retained the lowest (0.070%) capsaicin content (Fig. 6). Lower capsaicin content due to blanching treatment lead to some loss of volatile compound and open sun drying produces intense heat and ultraviolet radiation leads to the breakdown of capsaicin molecule. These results were in accordance with the previous studies conducted by Oberoi *et al*. (2007), Mihindukulasuriya and Jayasuriya (2013).

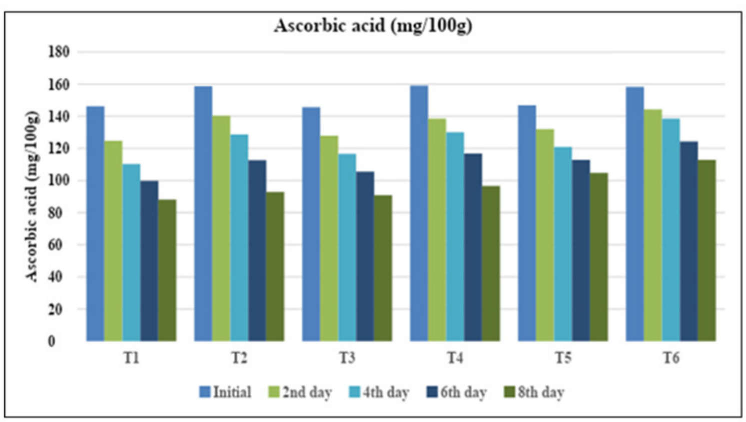


Fig. 5. Effect of blanching and drying methods on ascorbic acid content of fresh red chilli.

T_1 – Blanching + open sun drying, T_2 – Without blanching +open sun drying, T_3 –Blanching + solar tunnel drier, T_4 – Without blanching + solar tunnel drier, T_5 –Blanching + CAZRI drier, T_6 – Without blanching + CAZRI drier

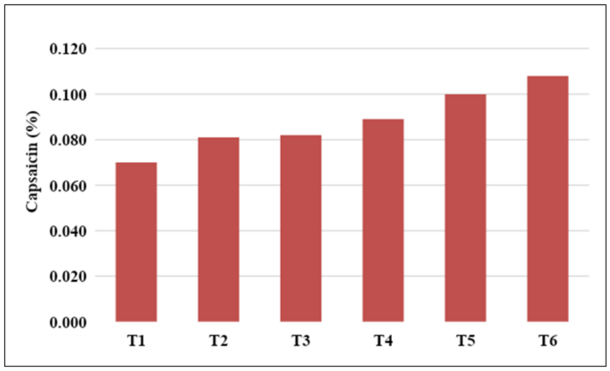


Fig. 6. Effect of blanching and drying methods on capsaicin content of dried red chilli.

I. Capsanthin (ASTA units)

The capsanthin cntent of chilli varied between 111.68 to 155.80 ASTA units (Fig. 7). The maximum (155.80 ASTA units) cpasanthin content was noticed in T_6 (Without blanching + CAZRI drier) and minimum capsanthin content was observed in T_1 (Blanching + open sun drying) (111.68 ASTA units). This might be due to blanching treatment involves heat treatment, which may lead to the degradation of capsanthin and exposure of chilli to sunlight may cause the oxidation of pigment. Similar findings were also recorded by Mangaraj *et al* (2001) and Sigge *et al* (2003).

J. Aflatoxin B1 (µg/kg)

The aflatoxin B1 content in dried chilli varied significantly among different treatments (Fig. 8), with an average of 0.85 µg/kg. Among the treatments, T_2 (Without blanching + open sun drying) showed the highest aflatoxin B1 content (2.14 µg/kg), followed by T_1 (Blanching + open sun drying) at 1.68 µg/kg. Aflatoxin content was high in case of sundried samples compared to other samples. This might be due to poor hygienic conditions that promote growth of moulds and production of mycotoxins (Martins *et al*., 2001) and high temperatures and humidity, it creates favorable conditions for fungal growth and aflatoxin production. The results are similar to the findings of Manjula and Ramachandra (2014) who reported that aflatoxin content was high in sundried samples compared to solar tunnel drier. However, aflatoxin B1 was not detected in T_3 (Blanching + solar tunnel drier) and T_5 (Blanching + CAZRI drier). But, the aflatoxin B1 levels found in the treatments were below the prescribed maximum permissible limit, indicating that they were not harmful.

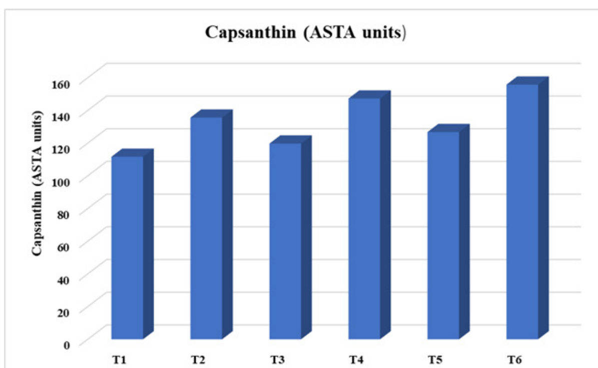
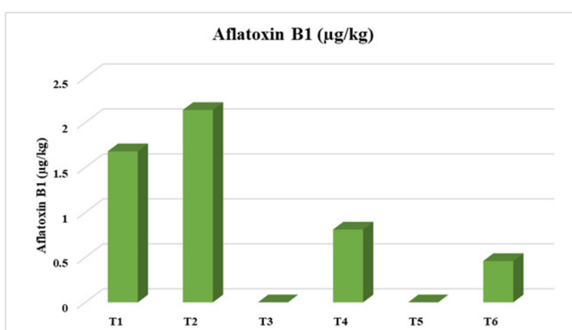


Fig. 7. Effect of blanching and drying methods on capsanthin content of dried red chilli.



T_1 – Blanching + open sun drying, T_2– Without blanching +open sun drying, T_3– Blanching + solar tunnel drier, T_4– Without blanching + solar tunnel drier, T_5– Blanching + CAZRI drier, T_6–Without blanching + CAZRI drier

Fig. 8. Effect of blanching and drying methods on aflatoxin B1 content of dried red chilli.

CONCLUSIONS

The fresh red chilli that was dried using the CAZRI drier had no aflatoxin contamination and had highest colour values (*L*, a*, b**), ascorbic acid, capsaicin, and capsanthin retention. Notably, the application of pre-drying blanching treatment not only accelerated the drying process but also contributed to the preservation of colour values in the dried chilli and attained less moisture, had low water activity was noticed in blanched red chilli, dried in solar tunnel drier.

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