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EFFECT OF BLANCHING TIME AND DRYING METHOD ON QUALITY OF BLACK PEPPER (*Piper nigrum*)

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ABSTRACT

Quality of black pepper highly depends on pre-drying treatment and drying method. A pre-drying treatment, blanching (dipping in boiled water), is practiced in different countries. However, Bangladesh is yet to follow this technique to produce black pepper. So, this study investigated the effect of blanching, blanching time, and drying method on black pepper quality. Pepper berries were treated in boiled water (blanched) for 1, 2, 3, 4, 5 minutes and kept fresh (untreated). Both treated and untreated pepper berries were dried under the open sun and in a mechanical dryer. Results showed that blanching time negatively correlated with drying duration for both mechanical and sun-drying method. Blanching limited the moisture content of dried pepper 5.33-11.52%, where the moisture content of untreated sun-dried black pepper was more than 12%. Mechanical dryer needed the lowest time over open sun-drying and decreased the moisture % to a safer level (<10%). The moderately blanched (1-3 min) black pepper was attracted by the consumers due to its uniform shiny black color. In contrast, untreated pepper could not meet the consumers' desire. Again, blanching for longer time deteriorated black peppers' color and consequently decreased consumers' preference level to buy.

Contribution/Originality: This study is one of the very few studies investigating the effect of blanching, blanching time, and drying method on the quality of black pepper.

1. INTRODUCTION

Black pepper is the processed end product of mature green pepper berries derived from the pepper (*P. nigrum*) plant (Thangaselvabal, Gailce Leo Justin, & Leelamathi, 2008). It is the widely used (approximately 472.500 thousand tons in 2017) spice in the world (Amarasinghe, Aberathna, & Aberathna, 2015). However, black peppers' commercialization is generally regulated by its' quality (Gu, Huang, Wu, & Zhu, 2018). This quality involves the pungency, color, and fresh aroma (Gu, Tan, Wu, Fang, & Wang, 2013; Rahimmalek & Goli, 2013). It is reported that black pepper quality depends on processing, *i.e.*, post-harvest technique (Joy, Pittappillil, & Jose, 2002; Mey et

al., 2017). Processing techniques include different pre-treatment techniques and drying methods (Deng et al., 2019).

Drying is a classical technique to prolong spices' storability as it decreases the products' moisture content (Jin, Mujumdar, Zhang, & Shi, 2018; Shreelavaniya & Kamaraj, 2017; Wang et al., 2017). After harvesting, matured green berries are generally sundried to produce black pepper (Dhas & Korikanthimath, 2003). Drying under open sunlight is a climate-dependent traditional technique, uncontrolled, labor-consuming, time-consuming, and unhygienic (Akinoso, Aremu, & Okanlawon, 2013). Besides these, prolonged drying time may increase the chance of microbial infection (Mey et al., 2017; Soysal, Ayhan, Eştürk, & Arıkan, 2009), which may produce unattractive grayish products (Govindarajan & Stahl, 1977). So, reduced drying time may decrease microbial infections. On the other hand, mechanical dryers, solar dryers, and electric dryers can reduce the drying time (Ravindran & Kallupurackal, 2001). There are massive works about different drying techniques on various food products. However, there is no literature on the drying of pepper in Bangladesh.

According to the name, black pepper attracts consumers by its' shiny black color and the only color that can affect 40% of the consumers' preference level to buy (Baardseth et al., 1988). So, Gu et al. (2018) considered blackening as a vital part of black pepper processing. The blackening can be enhanced by the blanching (dipping in boiling water) technique (Al-Amrani, Al-Alawi, & Al-Marhobi, 2020). The blanching technique is an effective pre-treatment for different herbs (Thamkaew, Sjöholm, & Galindo, 2020). It is also beneficial as it speeds up the drying rate (Weil, Sing, Méot, Boulanger, & Bohuon, 2017) and can decrease drying time to 44% (Krishnamurthy, Sampathu, Sowbhagaya, & Sankarayana, 1993). Moreover, the blanching technique cleans the product, washing out all kinds of foreign materials (Ravindran & Kallupurackal, 2001) and reduces microbes' activity from the black pepper surface sufficiently (Vandeweyer, Lenaerts, Callens, & Van Campenhout, 2017). However, blanching for a longer time can deactivate the enzymatic reaction of the browning process and discolor the final product and decrease the drying rate (Dhas & Korikanthimath, 2003; Wang et al., 2017). So, blanching time is a crucial factor in black pepper processing.

Meanwhile, Mey et al. (2017) recommended blanching at 100°C for 5 minutes on Kamchay black pepper. On the other hand, Gu et al. (2013) reported that color development is better when the green pepper berries are blanched at 100 °C for 10 minutes. Again, Central Food Technological Research Institute in Mysore stated that blanching in boiling water for 1(one) minute improved black pepper color and quality (Thangaselvabal et al., 2008). Risfaheri Hidayat (1996) suggested blanching for 1.5 to 5 minutes in hot water of 80°C. In India, blanching was practiced in boiling water for 1 min; in Papua New Guinea, Indonesia, and Micronesia, it was done at 82°C for 2 min (Pruthi, 1992).

There were large numbers of studies on pepper processing. However, existing studies showed various blanching time, temperature, and drying techniques on black pepper quality. It is reported that varietal diversification is an essential factor that differs for black pepper quality during processing (Joy et al., 2002). In Bangladesh, there is one variety of *Pipper nigrum* named Jointia Golmorich. To date, there is no literature on the processing technique of this variety. It is necessary to determine the processing technique (blanching time and drying method) for this variety. This study intended to find out blanching time at boiling water to retain the quality of black pepper and investigated the drying method's effect.

2. MATERIALS AND METHOD

Pepper berries were harvested from the Jaointia Golmorich (*Pipper nigrum*) garden of Hill Agricultural Research Station, Ramgarh, Khagrachari, in 2017. Harvesting was started when one or two berries per spike turned orange or red. Then the harvested berries were heaped for two days, and the fruits were despiked by trampling. The fresh pepper berries were stored at zero degrees centigrade (0^0C) at the Post-harvest Technology Division, Gazipur. Then those peppercorns were kept at room temperature for two hours and subjected to blanching. The

experiment was an RCBD factorial experiment. Blanching time was considered factor A (blanching time) T_0= No blanching and blanching for T_1= 1 minute, T_2= 2 minutes, T_3=3 minutes, and T_4= 4 minutes, and T_5 = 5 minutes. The materials were then dried, followed by factor B (drying method) M_1=sun drying and M_2=mechanical drying.

2.1. Blanching

The blanching of threshed pepper berries was carried out by placing the berries in a perforated vessel and then immersing the vessel in boiling water according to the treatment.

2.2. Sun-Drying

The blanched pepper berries were dried for 28 December 2017 to 6 January 2018 from 10 am to 3 pm under open sun.

2.3. Mechanical Dryer

For mechanical drying, GRIEVE hot-air oven dryer was used, and the drying temperature was 60°C. A temperature over 60°C may decrease the pepper quality (Shaw, Meda, Tabil, & Opoku, 2016).

For every treatment, 250-gram berry was used. Data on moisture content (%) and dry matter content (%) of fresh berries were measured on a wet basis (wb). Duration of drying (hours) and moisture content of dried berries (%) were recorded. Moisture content (%) was determined by drying in an oven at 103°C ± 1°C until the weight did not change anymore (Kashani Nejad et al., 2002).

2.4. Sensory Test

Twelve people who were experts in black pepper testing scored every treatment. Scoring was done for color and preference to buy. The score range was within 10.

Data were analyzed using software R. Mean separation was done by LSD at 5% level of significance.

Table-1. Temperature (0^0C) and relative humidity (%) of the drying days.

Date	Temperature (0^0C)	RH (%)
28-12-2017	23	76
29-12-2017	25	78
30-12-2017	30	80
31-12-2018	29	78
01-01-2018	28	81.4
02-01-2018	26	77
03-01-2018	28	78
04-01-2018	27	80
05-01-2018	27	78
06-01-2018	27	76

Source: Weather Station, Hill Agricultural Research Station, Khagrachari 2017-2018

3. RESULTS AND DISCUSSION

After harvest, the moisture content of Jointia Golmorich was 66.81% (wet basis), and dry matter content was 34.02%. This result was supported by Dhas and Korikanthimath (2003), who reported that moisture content and dry matter content of pepper berries might vary 60-70% and 29-43%, respectively, depending on varieties. Again, Darvishi *et al.*, 2013 reported 73.33% moisture content in green pepper, whereas (Shreelavaniya & Kamaraj, 2017) found 81.3% (wet basis) initial moisture content in Panniyur-I variety.

3.1. Drying Duration

Results showed that drying duration differed significantly for blanching time and drying method Table 2. Pepper berries that were not subjected to blanching (T_0) and dried traditionally under sunlight (M_1) needed the

highest time for drying (47.60 hours). The pepper berries blanched for 4 minutes (T_4) and dried mechanically (M_2) needed the lowest time for drying (18.00 hours), which was statistically similar to 5 minutes, 3 minutes, 2 minutes, and 1 minute blanched and mechanically dried pepper. Untreated pepper berries which were dried mechanically (60℃) needed 34.67 hours to decrease the moisture content to 7.31%. This result was different from Vera, Atienza, Capili, and Sauli (2017), who reported 13 hours of drying time in the oven at 50℃ for drying untreated pepper berries, and the moisture content was 7.505%.

Sun-drying for all the treatments needed higher time than mechanical drying. The reason may be that sun drying is a climate-dependent method, and temperature cannot be regulated. The temperature during sun-drying varied from 25-30℃ Table 1. On the other hand, in the mechanical dryer temperature was set for 60℃, which was uninterrupted. When the temperature was increased, the drying duration decreased. Vera et al. (2017) supported the result who explained that heat greatly affected the drying time.

Blanching treatment and drying duration were negatively correlated Figure 1 in the case of both drying methods. This result was also supported by Wang et al. (2017) and Weil et al. (2017). The lower drying duration in blanched berries may be due to the partial breakage of peppers' cell wall during blanching, which allowed the bonded moisture to diffuse quickly (Wang et al., 2017). This result was in harmony with the previous study by Sledz, Wiktor, Rybak, Nowacka, and Witrowa-Rajchert (2016) and Rocha, Lebert, and Marty-Audouin (1993), who found the highest drying rate in steam blanched parsley and steam blanched basil compared to the untreated product.

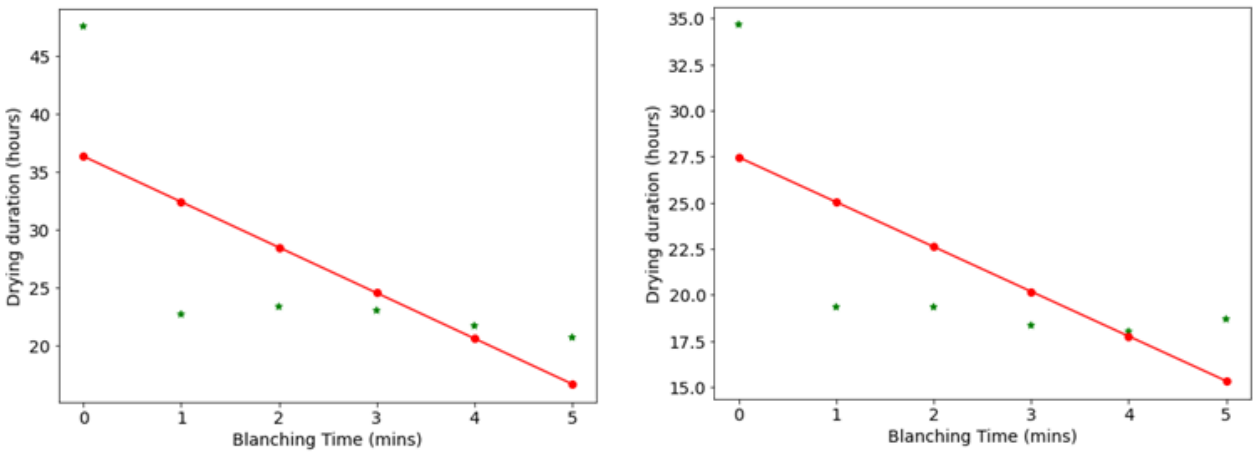

Figure-1. The negative correlation between blanching time (minutes) and drying duration (hours) for a. Sun-drying and b. Mechanical drying.

3.2. Moisture Content after Drying

Results showed that moisture content varied significantly for blanching time and drying method Table 2. After drying, moisture content was lowest in mechanically dried 1 min blanched pepper, which was statistically similar to 2, 4, and 5 minutes blanching followed by 3 minutes blanching. On the other hand, it was highest in untreated sundried pepper (14.12%) Table 2. Blanching decreased the moisture content of peppers than untreated black pepper Table 2. The result may be due to the breakage of cell tissue, increasing the drying rate and consequently decreasing the moisture content (Weil et al., 2017).

The moisture content of sundried pepper was not safe for storage, as moisture content over 12% can increase the chance of insect pest attack (vikaspedia). Dhas and Korikanthimath (2003) reported that moisture content should be less than 10% to store the product safely after drying. The mechanical dryer decreased the black peppers' moisture content to the safer limit (<10%) Table 2. This result may be due to high energy in mechanical dryers and

continuous evaporation of water from pepper berries (Dadali, Apar, & Ozbek, 2007; Soysal, Öztekin, & Eren, 2006; Wang et al., 2017). Akinoso et al. (2013) also said that climbing peppers' moisture loss was significantly affected by drying temperature.

As peppercorns are hygroscopic and so during storage, peppercorns absorb moisture from the weather. That is why moisture levels to 10-11% may stop mold growth (Thangaselvabal et al., 2008). So, moisture should be maintained in such a way so that microbial attack, chemical change of the product can be minimized (Krokida, Karathanos, Maroulis, & Marinos-Kouris, 2003).

Table-2. Drying duration (hours) and moisture content after drying (%) of untreated and blanched black pepper.

Blanching time	Drying duration (hours)				Moisture content after drying (%)			
	Sun-drying (M_1)		Mechanical drying (M_2)		Sun-drying (M_1)		Mechanical drying (M_2)	
T_0= No blanching	47.60	a	34.67	b	13.79	a	7.31	d
T_1= 1 min blanching	22.67	c	19.33	ef	12.30	b	5.33	f
T_2= 2 min blanching	23.33	c	19.33	ef	11.52	c	5.58	ef
T_3= 3 min blanching	23.00	c	18.33	f	11.25	c	6.06	e
T_4= 4 min blanching	21.67	cd	18.00	f	11.46	c	5.55	f
T_5 =5 min blanching	20.67	de	18.67	f	11.28	c	5.68	ef
LSD	1.70				0.49			
CV%	4.16				3.24			

Note: LSD= Least significant difference at 5% level.
CV%= Co-efficient of variation.

3.3. Scoring for the Color

The result showed that there is a significant difference in color for blanching time. There was no significant difference for the drying method. The highest scoring for color was in 2 minutes blanched pepper. The lowest-scoring for color was in 5 minutes blanched pepper for both drying methods. The result indicated that blanching for lower time (1-3 minutes)

in boiling water provide glossy uniform black color which was liked by the consumers. On the other hand, blanching for a longer time (4-5 minutes) and black pepper provided fade color. The result is also supported by Dhas and Korikanthimath (2003) who stated that uniform blackening could be accelerated by moderate blanching, and over blanching can deteriorate the color. The reason may be blanching for a longer time deactivated the blackening enzyme (Gu et al., 2013). Untreated, *i. e.* directly dried black pepper, was also scored low due to unattractive color Table 3 which was also reported by Gu et al. (2013). Gu et al. (2018) concluded that the black pepper was blacker in color and more uniform after the heat treatment (2 min 80℃) than the direct sun drying. The reason may be due to the partial breakdown of the cell wall during blanching, which helps in the oxidation of polyphenol. This PPO oxidation is responsible for blackening black pepper (Variyar, Pendharkar, Banerjee, & Bandyopadhyay, 1988; Weil et al., 2017). Weil *et al.*, 2017 pointed out the slight impact of blanching on color. The result was inconvenient to Gu et al. (2013), who reported blanching in 100 for 10 minutes produced black-brown color. Again, Central Food Technological Research Institute in Mysore stated that blanching in boiling water for 1(one) minute improved black pepper color and quality (Thangaselvabal et al., 2008). Risfaheri Hidayat (1996) suggested blanching for 1.5 to 5 minutes in hot water of 80°C. In India, blanching was done in boiling water for 1 min; in Papua New Guinea, Indonesia, and Micronesia it was done at 82°C for 2 min (Pruthi, 1992).

3.4. Scoring for Consumers' Preference to Buy

The result revealed that consumers' preference to buy the processed product differed significantly for both blanching time and drying method. Consumers' scoring was high to buy the black pepper, which was blanched for 2, 3, and 1 minute and dried mechanically. Consumers' scoring was low for untreated black pepper and black pepper,

which was blanched for 5, 4 minutes. Consumers preferred the moderately blanched pepper, which indicated that over blanching and no blanching harms pepper color and physical appearance. Weil et al. (2017) stated that blanching temperature and blanching duration were very crucial. The result can be explained that blanching deepened the black color and the products' physical appearance. On the other hand, higher blanching duration and no blanching deteriorated the pepper quality in color, aroma, and overall appearance.

Table-3. Scoring for color and consumers' preference to buy the untreated and blanched black pepper.

Blanching time	Scoring for color				Scoring for consumers' preference to buy			
	Sun-drying (M_1)		Mechanical drying (M_2)		Sun-drying (M_1)		Mechanical drying (M_2)	
T_0= No blancing	5.83	c	5.83	c	3.92	f	5.92	d
T_1= 1 min blanching	8.33	b	8.83	a	6.58	c	9.33	ab
T_2= 2 min blanching	9	a	9.1	a	6.67	c	9.67	a
T_3= 3 min blanching	8.67	ab	8.83	a	6.42	cd	8.83	b
T_4= 4 min blanching	5.17	d	5	d	3.25	g	4.58	e
T_5 =5 min blanching	5.17	d	5.17	d	2.92	g	4.25	ef
LSD	0.47				0.62			
CV%	3.93				6.12			

Note: LSD= Least significant difference at 5% level.
CV%= Co-efficient of variation.

The mechanically dried product was preferable to the sun-dried product. The reason may be due to the contamination during open sun-drying, which decreased the products' quality. Akinoso et al. (2013) also pointed out that sun-drying created the chance of admixture in food material and microbial attack.

4. CONCLUSION

The experimental results exhibited that blanching decreased the drying duration (18.00-23.33 hours). Moderately blanching (1-3 min) increased the scoring for color (8.33-9) and attracted consumers. Mechanical drying also decreased the drying duration (18.00-34.67%) and moisture content (5.33-7.31%). Besides these, the color of black pepper was not affected by the drying method. The chemical properties of black pepper after treatment were not studied. So, further study is required on black peppers' chemical properties.

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