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EFFECT OF WATER AND SODIUM CHLORIDE SOAKING ON THE QUALITY CHARACTERISTICS OF ARABICA AND ROBUSTA COFFEE

Channabasamma B.B.[1*], Gopinandhan, T.N.[1], Sandeep, T.N.[1], Shruthi H.[1] and Mandappa I.M.[2]

[1]Division of Post-Harvest Technology, Central Coffee Research Institute, Coffee Research Station Post – 577117, Chikmagalur District, Karnataka, India

[2]Division of Coffee Quality Evaluation, Coffee Board, Bengaluru- 560 001, Karnataka, India

*Corresponding author E-mail: channabasammabided@gmail.com

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ABSTRACT

Globally, coffee is processed by two methods *viz.,* wet and dry method. Wet method involves a series of steps *viz*., pulping of ripe cherries, fermentation of depulped cherries, washing of fermented coffee, post-wash soaking of washed coffee, sun drying of post-washed soaked coffee and bagging of dried coffee. The final product of wet processing is known as dry parchment coffee. Over the last few years, the coffee plantations in India are experiencing unprecedented rains during processing season (December to February) possibly due to the changing climatic conditions. These unseasonal rains occurring during processing season are hampering the routine course of processing leading to the loss of overall quality of coffee beans. Reports regarding preservation methods of coffee during the course of processing is an unexplored area in coffee research. Therefore, a study was taken up to assess the effect of sodium chloride (NaCl) soaking of washed coffee (also known as wet parchment) on the quality characteristics of arabica and robusta. The wet parchment of arabica and robusta varieties were soaked in clean water and two concentrations of NaCl (1% and 2.5%) with four treatments in triplicates [T_0-no soaking (local control); T_1-soaked for 4-days; T_2-soaked for 8-days; T_3-soaked for 12-days]. The coffee samples after soaking trial were washed with clean water and sun dried until the coffee attained the prescribed moisture level of 10%. The well dried parchment coffees (also called dry parchment) was dehusked to obtain the coffee beans. The quality parameters *viz.,* outturn percentage (quantity of coffee bean obtained from dry parchment) and organoleptic attributes were determined. The data indicated that the outturn percentage decreased with increasing concentration of NaCl and increasing soaking time (4, 8 and 12 days). In case of arabica, the outturn percentage decreased to the tune of 1.21% to 3.65% and from 1.17% to 4.11% in robusta, when compared to un-soaked sample (T_0). Regarding organoleptic quality, the organoleptic scores of un-soaked (T_0) and coffee soaked in water for 4-days (T_1) were found to be more or less similar (arabica: T_0 -70; T_1 -69 and robusta: T_0 - 68; T_1 -70). The influence of NaCl soaking on the organoleptic quality indicated that coffee samples soaked in 1% NaCl for 4-days (T_1) scored comparatively higher scores (arabica-73; robusta-71), as compared to T_0 treatment (arabica-70; robusta-68). Prolonged soaking of wet parchment for 8-days (T_2) and 12-days (T_3) resulted in complete deterioration of organoleptic quality, regardless of soaking medium. These results suggested that wet parchment can be stored in clean water or 1% NaCl solution to a maximum four days only.

Keywords **:** Coffee, Outturn percentage, organoleptic attributes, Sodium chloride, Wet processing.

Introduction

Coffee is the second most important commodity exchanged in the world market next to crude oil (Anonymous, 2025). Although there are more than one-hundred coffee varieties reported to be present in the nature, arabica and robusta are the two main coffee varieties grown on commercial scale worldwide (Mishra *et al*., 2014). Coffee is grown in about eighty countries in the world and India is the seventh largest producer of coffee in the world with 4.70 lakh ha of land under coffee cultivation (Arabica-2.42 lakh ha; Robusta-2.28 lakh ha). The total coffee production in India was 3.43 lakh MT during 2022-2023 harvest season (Anonymous, 2024).

Coffee is processed by one of two methods at the estate level *viz.,* wet, and dry. In India, wet processing is largely employed for arabica coffee while dry processing is mostly followed for robusta coffee. In India, 85% of arabica and 15% of robusta coffees are wet processed and the remaining quantities are dry processed. In dry processing, the harvested cherries are sorted out to remove the over-ripe, tree-dried, diseased and damaged cherries. The ripe cherries are dried in sun until the moisture attains to 11%. The final product of dry processing is known as cherry coffee (Anonymous, 2023).

In wet processing, immediately after harvesting, the ripe coffee cherries go through a water flotation process to remove the floaters (low-density cherries) and debris. The well matured ripe cherries are pulped (to remove the fruit skin), fermented (to digest the mucilage surrounding the coffee beans), washed (to remove the digested mucilage), post-wash-soaked (to remove the residual mucilage, if any) and sun dried until the moisture level reaches to 10%. The washed coffees are also known as "wet parchment" while the end product of wet processing is called as "dry parchment" (Anonymous, 2023). The processing steps involved in the wet processing right from harvesting until drying are to be carried out in continuum to preserve the intrinsic coffee quality. Any disruptions during the course of wet processing will result in deterioration of the intrinsic quality of coffee.

Over the past one decade, the changing climatic conditions are affecting the production and quality of all agricultural crops including coffee. The erratic rainfall pattern and unseasonal rainfall occurring during the critical phases of the coffee farming are affecting both yield and quality. Further, the unseasonal rains occurring during coffee processing disrupts the progression of coffee from one step to another step which necessitates to look for methods for the preservation of partially processed (unfinished) coffee.

Reviewing of literature relating to the post-harvest management of coffee revealed that authors have studied the effect of soaking freshly harvested cherries in water (Pauline *et al*., 2017) and soaking of wet parchment in sodium-meta-bi-sulphite as well as organic acids with an objective of improving the overall quality of coffee (Subramanian and Ashwat Kumar, 1968; Anand Alwar and Krishnamurthy Rao, 1980; Velmourougane, 2011; Jorge and Luis, 2024). Few other studies have demonstrated the effect of combination of organic acids and sonication on the organoleptic qualities of coffee beans (Haeun *et al*., 2023; Deden *et al*., 2024).

Historically, sodium chloride (NaCl) is used for increasing the safety and shelf-life of the food commodities (He and Mac Gregor, 2007). Further, sodium chloride is reported to enhance flavour by suppressing the bitterness (Breslin and Beauchamp, 1995; Breslin and Beauchamp, 1997; Gillette, 1985). Considering the potential benefits of sodium chloride as a preservative and flavour enhancer, a study was undertaken with an objective of studying the effect of two dosages of sodium chloride (1% and 2.5%) for different soaking time (4, 8 and 12 days) on extending the shelf-life of wet parchment (an unfinished coffee product in wet processing) and organoleptic quality of both arabica and robusta cultivars.

Materials and Methods

The experiment was carried out at the research farm in central coffee research institute (CCRI) located at Chikkamagaluru district in Karnataka state (India) in 2023-24 harvest season. Analytical grade sodium chloride salt (SD Fine Chem Limited) and double distilled water was used for preparing the soaking medium.

Fresh ripe cherries of Arabica (selection no. 9) and Robusta (selection no.3) varieties were harvested manually. The ripe cherries were soaked in clean water and those cherries which floated on the surface of the water (known as floater cherries or lighter cherries) were removed manually. The well matured cherries were pulped using Colombian make motorized pulper (Penagos pulper model DH4). The resulting pulped beans were fermented adequately (approximately 20 hours for arabica and 60 hours for robusta) to remove the mucilage surrounding the beans (mucilage generally consist of pectin, sugars and protein). The fermented beans were washed manually in clean water repeatedly until all the digested mucilage removed from the coffee. The resulting coffee is generally known as "wet parchment/washed parchment" was soaked in clean water (positive control), 1% NaCl solution (10,000 ppm) and 2.5% (25,000 ppm) solution with the following treatments in triplicates: T_0 (no soaking-local control), T_1 (soaked for 4-days), T_2 (soaked for 8-days) and T_3 (soaked for 12-days). The wet parchment samples after soaking, were washed in clean water and then sun dried until the coffee reached the prescribed moisture level of 10%. The resulting coffee samples are generally called as "dry parchment". The moisture content in dry parchment samples was determined using calibrated digital moisture meter (Sinar Technology, England Model AP 6060).

The dry parchment samples were de-husked using peeler-cum-polisher machine (Marshall-Fowler Group, UK Model PP7/LS 407) to obtain coffee bean sample. The coffee beans were garbled to remove all the non-coffee extraneous matters. The outturn percentage was calculated using the standard formula (quantity of coffee beans obtained/quantity of dry parchment hulled x 100). The coffee bean sample from different treatments were submitted at the coffee quality evaluation division of CCRI for organoleptic evaluation and the evaluation was done following the methods outlined in "The Coffee Cuppers Handbook" of the Speciality Coffee Association (Anonymous, 2023).

Results and Discussion

a) Influence of water and sodium chloride soaking of wet parchment on outturn percentage

Outturn (OT) is an important post-harvest parameter in coffee and it refers to the amount of coffee bean obtained from dry parchment. The OT percentage commands price in the market and coffee with higher OT percentage fetches higher prices. As per the International Coffee Organization, the minimum OT percentage for parchment and cherry coffee are 80 and 50 respectively (Anonymous, 2025). According to the coffee board of India, the OT percentage for parchment and cherry coffees are 82 to 85 and 50 to 54, correspondingly (Anonymous, 2023).

The data on the influence of water and NaCl soaking of wet parchment on OT percentage indicated that (Table 1) the OT percentage decreased with increasing soaking time (4, 8 and 12 days) and increasing concentration of NaCl (1% and 2.5%). In case of arabica, water-soaked coffee samples showed a gradual reduction in OT percentage as the soaking time increased and the reduction was to the tune of 1.21% to 3.65% when compared to local control sample (T_0). Similar trend was observed even in water soaked robusta coffee sample and the reduction in OT ranged from 1.17% to 4.11%. As in case of water-soaked coffee samples, coffee samples soaked in NaCl solution also exhibited a gradual reduction in OT percentage as the soaking time increased. Coffee sample soaked in 2.5% NaCl for 12-days registered the highest reduction of 3.65% in arabica and 5.88% in robusta as compared to local control treatment (T_0). The reduction of OT percentage observed in the current study may possibly due to leaching of various water-soluble organic molecules *viz*., sugars, proteins, tannin and phenolic compounds from the coffee beans. This result was similar to those of Mburu (1999) and Chujiao *et al*., (2018) who reported loss of organic molecules *viz*, sucrose and protein from coffee beans to the extent of 1.6% to 7%.

Table 1 : Influence of water and NaCl soaking on outturn percentage

Treatments	Arabica			Robusta		
	Water soaking	1% NaCl	2.5% NaCl	Water soaking	1% NaCl	2.5% NaCl
T_0 - No soaking	82.0 ± 0.13	82.0 ± 0.13	82.0 ± 0.13	85.0 ± 0.42	85.0 ± 0.42	85.0 ± 0.42
T_1 - 4 days soaking	81.0 ± 0.41 (1.21%)	81.0 ± 0.10 (1.21%)	80.5 ± 0.12 (1.82%)	84.0 ± 0.46 (1.17%)	83.5 ± 0.27 (1.76%)	83.0 ± 0.32 (2.35%)
T_2 - 8 days soaking	80.0 ± 0.37 (2.43%)	80.5 ± 0.50 (1.82%)	79.0 ± 0.44 (3.65%)	82.5 ± 0.72 (2.94%)	82.0 ± 0.50 (3.52%)	81.5 ± 0.46 (4.11%)
T_3 - 12 days soaking	79.5 ± 0.22 (3.04%)	79.5 ± 0.54 (3.04%)	79.0 ± 0.74 (3.65%)	81.5 ± 0.56 (4.11%)	81.5 ± 0.10 (4.11%)	80.0 ± 0.52 (5.88%)
Values in parenthesis are reduction in OT percentage as compared to T_0 sample						

b) Influence of water and sodium chloride soaking of wet parchment on organoleptic quality

The data on the influence of soaking wet parchment in water and different levels of NaCl solution on organoleptic score and individual quality attributes are depicted in Fig 1 & 2 and tables 2, 3 & 4 respectively.

The influence of water soaking of wet parchment on organoleptic quality indicated that in case of arabica, among the various treatments, un-soaked coffee sample scored 70 points (T_0) followed by 69 points for the coffee soaked in water for 4-days (T_1). Coffee samples soaked in water for 8 (T_2) and 12 (T_3) days scored very poor cup scores of 3% and 0%, respectively (Fig 1). In robusta, similar trend was observed (Fig 2) and the cup scores ranged from 18 to 68 (T_0-68; T_1-70; T_2-19; T_3-18). The effect of NaCl soaking on the organoleptic quality revealed that coffee samples soaked in 1% NaCl for 4-days (T_1) scored comparatively higher scores (arabica-73; robusta-71) as compared to T_0 treatment (arabica-70; robusta-68). As the NaCl concentration and soaking time increased,

the cup score decreased linearly and the reduction of cup score was very significant in arabica samples when compared to robusta samples (Fig 1 & 2). Prolonged soaking of wet parchment for 8-days (T_2) and 12-days (T_3) resulted in complete deterioration of organoleptic quality, regardless of soaking medium.

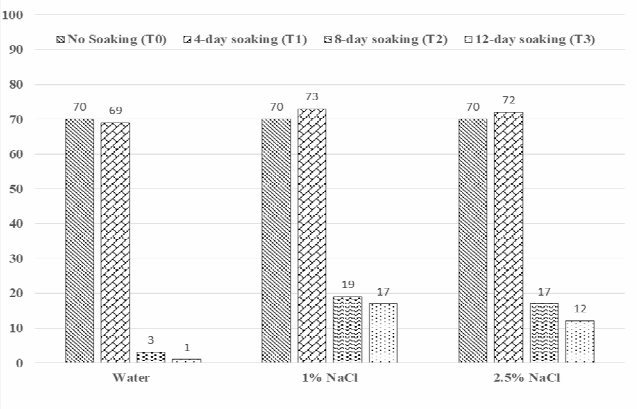

Fig 1 : Influence of water and NaCl soaking on organoleptic quality of arabica coffee

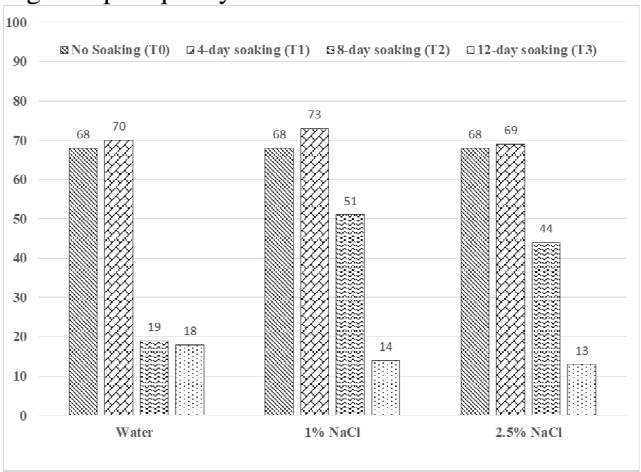

Fig. 2 : Influence of water and NaCl soaking on organoleptic quality of robusta coffee

Table 2 : Influence of water soaking of wet parchment on various quality characters of coffee

Quality character	Arabica				Robusta			
	Control	4 days	8 days	12 days	Control	4 days	8 days	12 days
Aroma	6.25	6.5	3.0	2.0	6.5	6.75	3.25	2.25
Flavour	6.0	6.0	3.0	2.0	6.25	6.50	3.0	2.0
Body	5.75	6.0	4.0	2.0	6.0	6.5	4.5	2.0
Salt/Acid	6.25	6.0	3.25	2.0	6.5	6.25	3.25	1.75
Bitter/sweet	6.0	6.25	2.0	1.75	6.25	6.25	2.0	2.5
Mouth feel	6.0	6.25	2.25	1.75	6.25	6.25	2.0	1.5
Clean cup	10	10	0	0	10	10	0	0
After taste	6.0	6.0	2.0	1.75	6.25	6.25	2.0	2.5
Balance	6.0	6.5	2.0	1.5	6.25	6.5	2.0	2.25
Overall	6.0	6.52	2.0	1.5	6.25	6.5	2.5	1.75
Defects/Deduction	0.0	0.0	20.0	20.0	0.0	0.0	20.0	20.0

Table 3 : Influence of NaCl soaking of wet parchment on quality characteristics of arabica

Quality characters	Control	1% NaCl			2.5% NaCl		
		4 days	8 days	12 days	4 days	8 days	12 days
Aroma	7.0	7.5	5.5	4.75	7.5	4.5	4.0
Flavour	6.75	7.25	4.5	4.25	7.25	4.0	3.25
Body	6.75	7.0	4.5	4.5	6.75	5.0	5.75
Salt/acid	6.5	7.5	4.25	4.25	7.25	4.5	4.0
Bitter/sweet	6.75	7.25	4.0	4.0	7.0	4.0	3.0
Mouth feel	7.0	7.25	5.25	4.0	7.0	3.5	3.0
Clean cup	10.0	10.0	0	0	10	0	0
After taste	6.75	7.25	4.5	4.0	7.0	3.5	3.0
Balance	6.75	7.25	4.5	4.0	7.25	3.5	3.0
Overall	6.75	7.5	4.5	4.5	7.25	4.0	3.75
Defects/deduction	0	0	20	20	0	20	20

Table 4 : Influence of NaCl soaking of wet parchment on quality characteristics of robusta

Quality characters	Control	1% NaCl			2.5% NaCl		
		4 days	8 days	12 days	4 days	8 days	12 days
Aroma	6.5	7.0	5.0	4.5	6.75	5.0	4.0
Flavour	6.25	6.75	4.5	4.0	6.25	4.5	3.75
Body	6.0	6.75	4.5	4.25	6.5	5.5	4.0
Salt/Acid	6.5	6.75	4.25	4.0	6.5	4.0	4.0
Bitter/sweet	6.25	6.5	4.0	4.0	7.0	4.5	4.0
Mouth feel	6.25	6.5	4.25	4.0	7.0	4.0	3.0
Clean cup	10	10	0	0	10	0	0
After taste	6.25	6.5	4.25	4.0	7.0	4.0	3.0
Balance	6.25	6.75	4.25	4.0	6.50	4.0	3.0
Overall	6.5	6.75	4.25	4.0	6.25	4.0	3.0
Defects/deduction	0	0	20	20	0	20	20

A closer examination of organoleptic scores revealed that coffee samples soaked in 1% NaCl scored slightly higher values as compared to coffee samples soaked in 2.5% NaCl indicating 1% NaCl concentration seems to be optimal in bringing out a balanced organoleptic attribute in coffee samples. This result was akin to the findings of Hana *et al*. (2025) who reported that the quality of tempeh-based soy sauce stored at 15% concentration of NaCl showed better quality index when compared to other NaCl concentrations tested (10%, 12.5%, 17.5% & 20%).

Conclusion

The results of the current study revealed that wet parchment soaked in clean water (T_0) and 1% NaCl solution for 4-days (T_1) showed the least reduction of OT percentage (1.21% in arabica and 1.17% to 1.76% in robusta) when compared to other soaking condition (2.5% NaCl) and treatments (T_2 and T_3). Further, the organoleptic scores of un-soaked (T_0) and coffee samples soaked for 4-days (T_1) were found to be almost on par, as compared to other soaking condition (2.5% NaCl) and treatments (T_2 and T_3). The results of the present study and the recent publications regarding role of sodium on improving quality attributes (Koji, 2024; Nnenna and Dornubari, 2025) indicated that optimal addition of sodium chloride improves the organoleptic attributes while increasing the shelf-life of food commodities. The findings of the current study suggest that wet parchment can be stored in clean water or 1% NaCl solution up to four days only during unforeseen conditions.

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