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Impact of Blanching Treatments on the Physico-chemical Attributes of Curry Leaves Dried Using Solar Tunnel Technology

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this research was to assess the physico-chemical properties of curry leaves subjected to different blanching treatments (0 min, 3 min, 5 min) using a solar tunnel dryer. The moisture content was found to be 8.37%, indicating effective drying. The highest carbohydrate

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content was recorded at 54.02%, demonstrating a strong retention of nutritional quality. Ascorbic acid content was 2.69%, and the ash content stood at 6.63%, reflecting the mineral profile. The curry samples contained 5.30% crude fat, 7.88% protein, and 10.59% crude fiber, underlining their nutritional worth. Chlorophyll content was measured at 3.15 %, which could affect the color and overall quality of the dried product. The bulk density was recorded at 451.67 mg, contributing to the product’s physical characteristics. The WSI and WAI values were 58.37% and 260.64%, respectively, indicating favourable rehydration properties. The recovery rate was 25.51%, providing insight into the drying process's efficiency. This study underscores the potential of solar tunnel drying in preserving the quality and nutritional value of curry leaves under various blanching conditions.

Keywords: Curry leaves; physico-chemical; blanching treatments; solar tunnel dryer.

1. INTRODUCTION

Renewable energy sources come in various forms such as solar energy, wind energy, biomass, hydropower, geothermal energy, and more, solar energy stands out as the most cost-effective, inexhaustible, and abundant source, providing a direct form of energy. It is one of the most plentiful renewable energy sources, with the sun emitting energy at a rate of 3.8 x 10^{23} kW of this immense output, approximately 1.8 x 10^{14} kW is intercepted by Earth, a figure roughly ten times greater than the current global annual energy consumption. In theory, solar energy has the potential to meet all current and future global energy demands continuously. Furthermore, solar energy is a clean, environmentally friendly, and freely available resource, accessible in sufficient quantities across almost every region of the world.

Medicinal plants, rich in secondary metabolites, serve as potent sources of drugs. India and China are major producers of medicinal plants, contributing over 40% of global production. India, one of the world's 12 biodiversity centers, boasts over 45,000 plant species across 126 agro-climatic zones, 10 vegetation zones, 25 biotic provinces, and 426 biomes. With 80% of the global population relying on traditional medicines derived from plants due to the high cost of Western pharmaceuticals, there is a growing need to promote and protect this traditional knowledge.

Reviving and updating traditional wisdom with modern science can lead to value-added products like medicines, nutraceuticals, and cosmeceuticals, which are crucial for human welfare. This approach will help reduce the financial burden on developing countries and ensure the sustainable use of medicinal plants.

The curry plant (*Murraya koenigii* L. Spreng) has significant potential in Jambi Province due to its ease of cultivation, and it is commonly used as a spice in processed meat. Curry leaves produce essential oils that are widely utilized as cooking spices (Vorster et al., 2005; Kakade et al., 2015). Additionally, curry leaves possess antibacterial properties (Mwangi and Mumbi, 2006), antioxidants (Anonymous, 1999), and antimicrobial effects (Anonymous, 2018). The function of the curry plant leaves is crucial, as they are responsible for photosynthesis. The size and function of the leaves in plant growth contribute to variations in biomass production, as the leaves' ability to produce reduced carbon directly impacts the production of plant biomass. As a result, leaf development is an important parameter for analyzing plant growth (Anonymous, 2010; Wani and Kumar, 2018; Simopoulos and Gopalan, 2003). Curry leaves are smaller than bay leaves and are compound, pinnate in shape with long stalks, typically having an odd number of leaflets, ranging from 11 to 21. Accurate and rapid measurement techniques are required to assess leaf growth, one of which is the millimetre column method. Estimating leaf area can also be done using millimetre chart paper (Schurer, 1971). And objective of these research was to find physico-chemical analysis of fresh and dried curry leaves.

2. MATERIALS AND METHODS

2.1 Experimental Details

2.1.1 Procurement of medicinal plant leaves

The medicinal plants namely, curry leaves, was procured from the local farm of the Junagadh, Gujarat. Harvesting of curry leaves were carried out by a wooden rod having a sharp stainless-steel knife at the top for cutting the leaves. Then after, damaged and discoloured leaves were separated manually by hand picking.

2.1.2 Pre-treatments

The freshly harvested medicinal plant leaves were subjected to different levels of pre-treatment (steam blanching for 3 and 5 minutes) prior to solar tunnel drying and sun-drying. Many researchers have suggested that steam blanching prior to drying will improve sensory qualities (colour, flavour, taste, fragrance, aroma, etc), permits longer storability.

2.2 Physio-chemical Analysis of Raw and Dried Products

The physio-chemical analysis of the raw leaves, i.e., freshly harvested leaves and that of the dried leaves powder was carried out in the Department of Food Processing Engineering, College of Agriculture Engineering and Technology, JAU, Junagadh. The parameters determined were carbohydrate content, ascorbic acid content, total ash content, fat content, protein content, crude fibre content, bulk density, recovery rate, WSI and WAI as mentioned in Tables 1 and 2.

2.2.1 Carbohydrate content determination

To determine carbohydrate content, phenol sulphuric acid method was used.

2.2.2 Ascorbic acid content determination

To determine the ascorbic acid content in the sample, DNPH method was used as recommended by Roe (1961). In this study, 0.1 g of each of the sample was taken and extracted with 6% trichloro acetic acid (TCA) in 10 ml of 80% H_2SO_4. Aliquot of 0.2, 0.4, 0.6, 0.8 and 1.0 concentration were formed. In it, 2 ml of 2% 2,4Dinitrophenylhydrazine (DNPH) and 10% thiourea was added and the whole set up was kept in water bath of 80ºC for 15 minutes.

Table 1. Treatment details of different blanching time and drying methods

Sr. No.	Type of Variable	Levels	Details
		Independent Variable	
01	Crop leaves	1 level	C – Curry Leaves
02	Steam blanching time	3 levels	S_1 – 0 min S_2 – 3 min S_3 – 5 min
03	Drying method	2 levels	D_1 – Solar Tunnel Drying D_2 – Sun Drying
		Dependent Variable	
04	Parameters	1. Physical parameter: Bulk density. 2. Biochemical parameter: Moisture content, carbohydrate, ascorbic acid, total ash, fat, fiber, and protein content. 3. Functional parameter: WSI, WAI, Recovery rate.	
		Treatment Details	
05	Treatments	6	
06	Repetitions	3	
07	Statistical design	3 - Factor Completely Randomised Design	

Table 2. Treatment combination details of different blanching time and drying methods

Treatment No.	Treatment Details	Combinations
1	Curry Leaves (C) + 0 min Steam blanching(S_1) + Solar Tunnel Drying (D_1)	CS_1D_1
2	Curry Leaves (C) + 3 min Steam blanching(S_2) + Solar Tunnel Drying (D_1)	CS_2D_1
3	Curry Leaves (C) + 5 min Steam blanching(S_3) + Solar Tunnel Drying (D_1)	CS_3D_1
4	Curry Leaves (C) + 0 min Steam blanching(S_1) + Sun Drying (D_2)	CS_1D_2
5	Curry Leaves (C) + 3 min Steam blanching(S_2) + Sun Drying (D_2)	CS_2D_2
6	Curry Leaves (C) + 5 min Steam blanching(S_3) + Sun Drying (D_2)	CS_3D_2

2.2.3 Ash content determination

Total ash content was determined by combustion method as described in AOAC (2005).

2.2.4 Crude fat content determination

Crude fat content was determined as the weight change recorded after exhaustively extracting the leaf samples with a non-polar solvent (hexane) using soxlet method according to AOAC (2005).

2.2.5 Protein content determination

To determine the protein content of Curry leaves, Follin Lowry method was adopted, recommended by Waterborg (2009).

2.2.6 Crude fibre content determination

Crude fibre percentage was determined by extraction method with the help of fibre them according to AOAC (2005).

2.2.7 Bulk density

Bulk density is defined as ratio of weight of an untapped material to its volume including the contribution of the inter-particulate void volume.

2.2.8 Percentage recovery

The percentage recovery was determined according to the formula given by Anderson (1982).

2.2.9 Water solubility index (WSI)

The solubility was determined according to the method suggested by Anderson (1982).

2.2.10 Water absorption index (WAI)

The absorptivity was determined according to the method suggested by Anderson (1982).

2.2.11 Chlorophyll content test

The chlorophylls are vital components for photosynthesis and occurs as green pigment in chloroplast of all plant tissue. The chlorophyll was determined by colorimetric method described by Sadasivam (1996). According to this method, 0.2 g green leaves sample was ground by adding 80% acetone. After that it was centrifuged and collected the supernant in 10 ml centrifuge tube. Repeated this procedure until the sample became colourless. The absorbance was recorded at 645 and 663 nm against blank. The amount of chlorophyll present in extract was obtained using the following expression.

3. RESULTS AND DISCUSSION

The physio-chemical and function properties of raw leaves and dried leaf powder of Curry leaves as, viz., carbohydrate content, moisture content, fat content, fibre content, ascorbic acid content, protein content, ash content, bulk density, recovery rate, chlorophyll content, WAI and WSI were determined in the Processing and Food Engineering department of CAET, JAU, Junagadh as per the standard methods.

3.1 Carbohydrate Content

The graph below shows that the range of carbohydrate content vary from 43.82 to 54.02% for curry leaves. The highest amount of carbohydrate content was found in curry leaves which was pretreated by steam blanching for 3 min and dried using solar tunnel dryer and carbohydrate content was found in unblanched sun dried.

3.2 Moisture Content

The graph below shows that the range of Moisture content vary from 8.37% to 6.26% for curry leaves. The highest amount of moisture content was found which was unblanched sun dried and minimum moisture content was found in 5 min blanched samples.

3.3 Ascorbic Acid

The graph below shows that the range of ascorbic acid content vary 2.13% to 2.69% for curry leaves. The highest amount of ascorbic acid content was found which was pretreated by steam blanching for 3 min and dried using solar tunnel dryer and minimum ascorbic acid content was found in unblanched sun dried.

3.4 Total Ash

The graph below shows that the range of ash content vary from 7.88% to 12.875% for curry leaves. The highest amount of ash content was found which was pretreated by steam blanching for 3 min and dried using solar tunnel dryer and minimum ash content was found in unblanched sun dried.

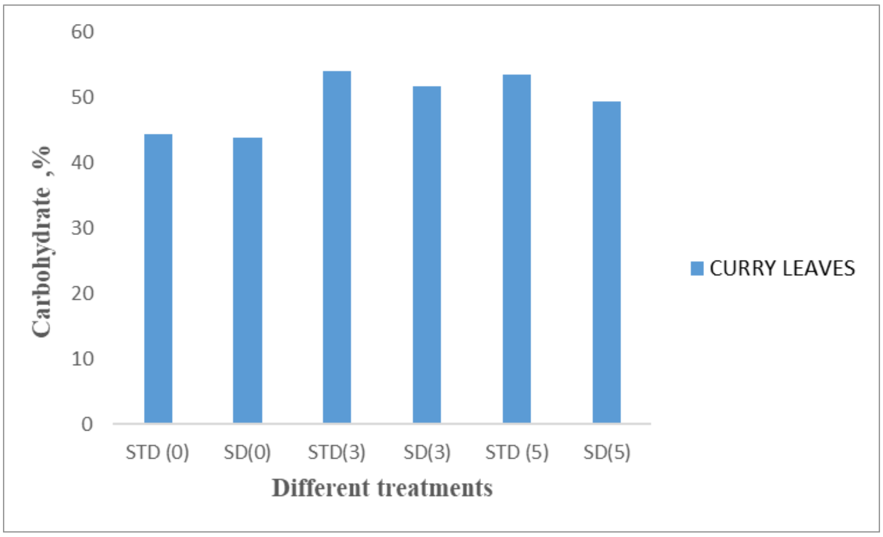

Fig. 1. Carbohydrate content of dried powder Curry leaves

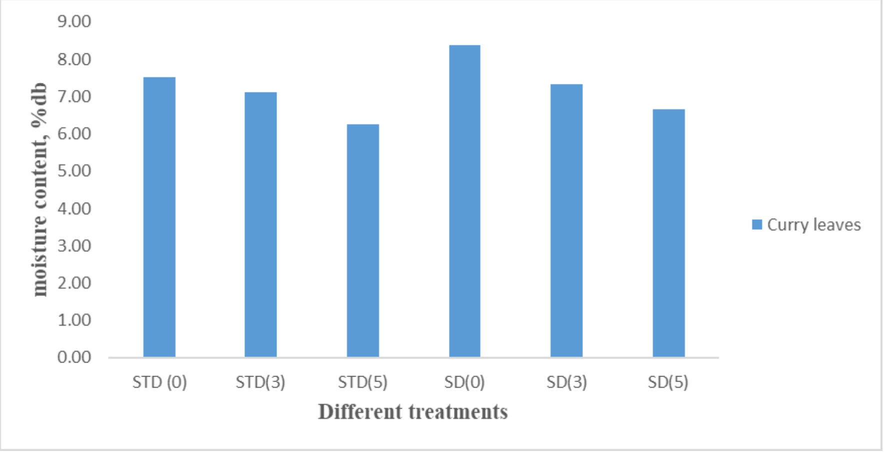

Fig. 2. Moisture content of dried curry leaves

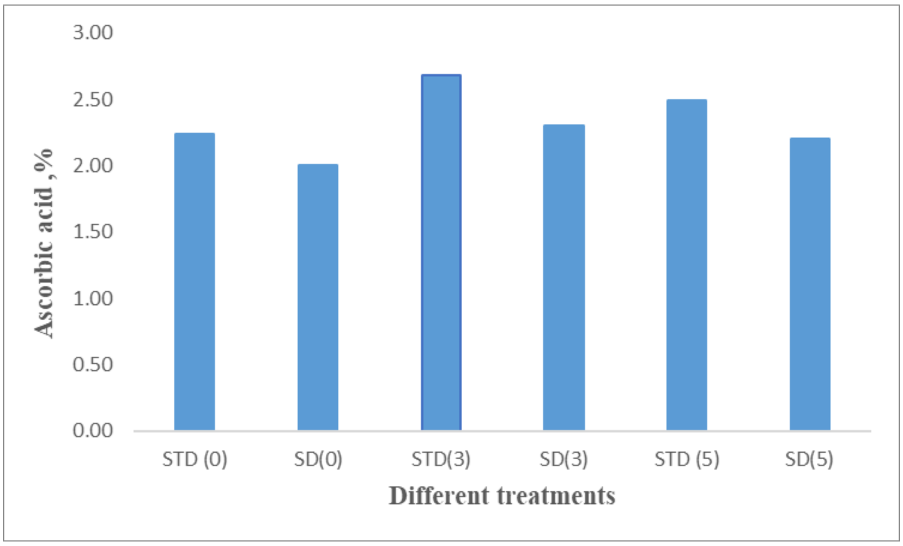

Fig. 3. Ascorbic acid content of dried powder curry leaves

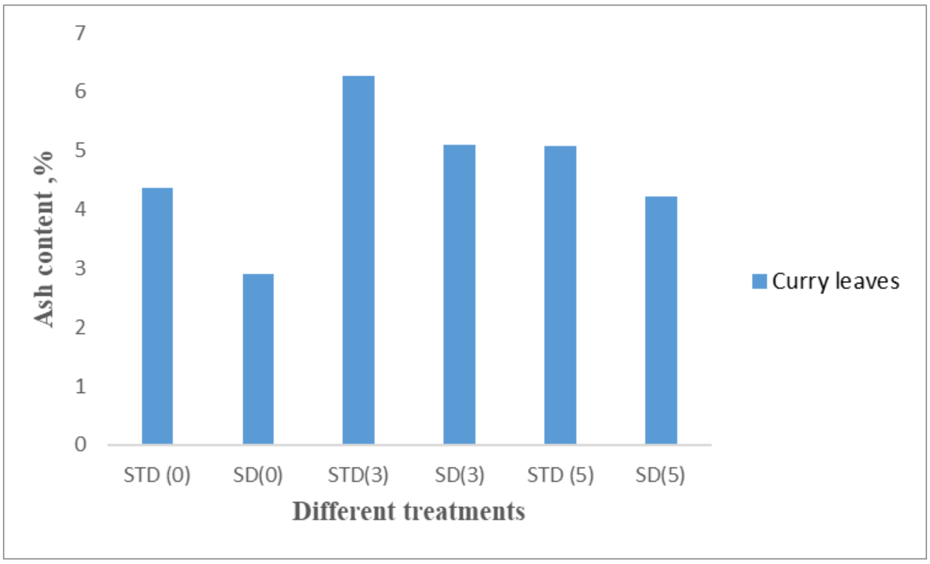

Fig. 4. Ash content of dried powder curry leaves

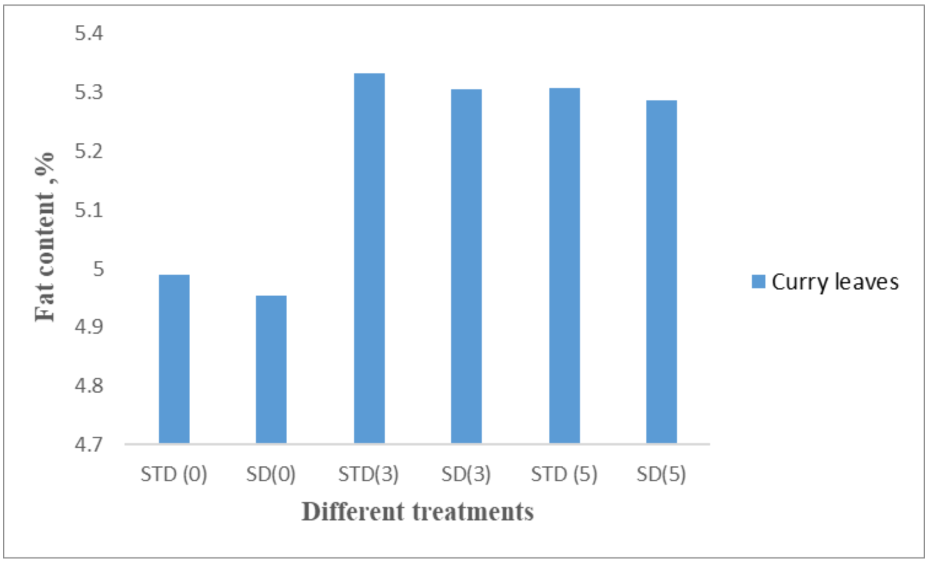

Fig. 5. Fat content of dried powder curry leaves

3.5 Fat Content

The graph below shows that the range of fat content vary from 5.305% to 4.91% for curry leaves. The highest amount of fat content was found which was pretreated by steam blanching for 3 min and dried using solar tunnel dryer and minimum fat content was found in unblanched sun dried.

3.6 Protein Content

The graph below shows that the range of Protein content vary from 10.59% to 9.39% for curry leaves. The highest amount of protein content was found which was pretreated by steam blanching for 3 min and dried using solar tunnel dryer and minimum protein content was found in unblanched sun dried.

3.7 Fibre Content

The graph below shows that the range of Fiber content vary from 12.9% to 8.475% for curry leaves. The highest amount of fibre content was found which was pretreated by steam blanching for 3 min and dried using solar tunnel dryer and minimum fibre content was found in unblanched sun dried, respectively.

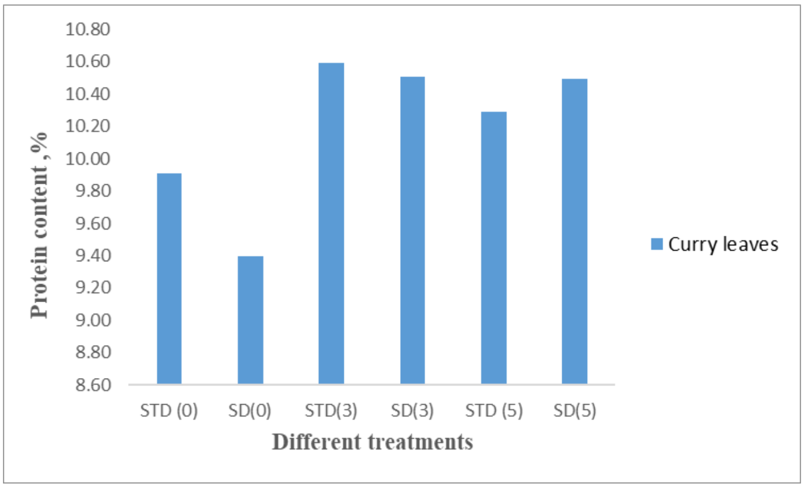

Fig. 6. Protein content of dried powder curry leaves

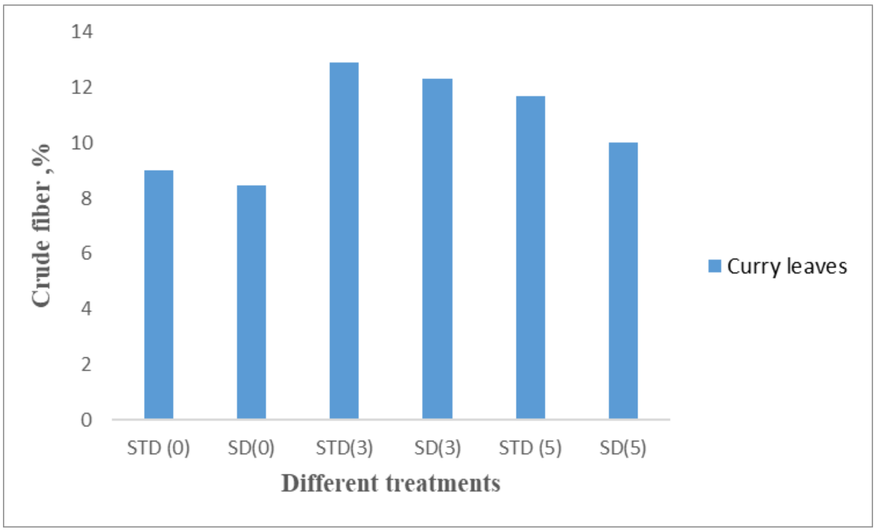

Fig. 7. Ash content of dried powder curry leaves

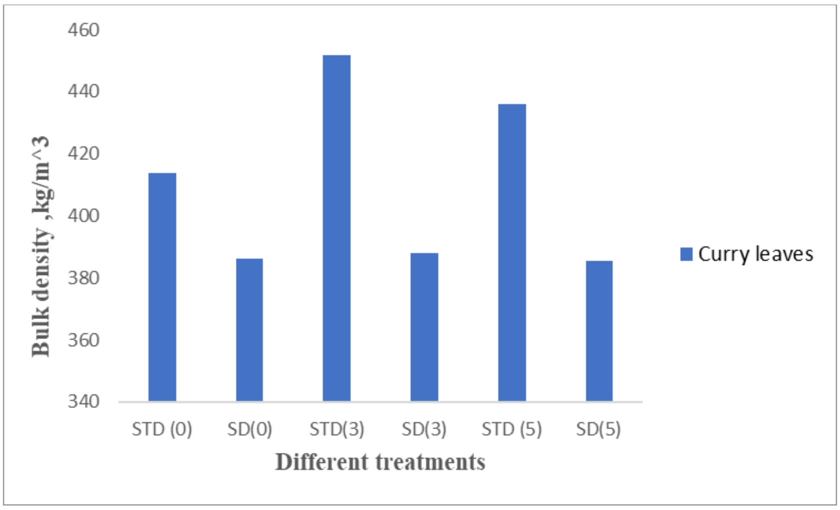

Fig. 8. Bulk density of dried powder curry leaves

3.8 Bulk Density

The graph below shows that the range of Bulk density vary from 451.67 to 385.33 kg/m^3 for curry leaves. The highest amount of bulk density was found which was pretreated by steam blanching for 3 min and dried using solar tunnel dryer and minimum fibre content was found in unblanched sun dried.

3.9 Water Solubility Index

The graph below shows that the range of WSI content vary from 28.37% to 20.53% for curry leaves. The highest amount of bulk density was found which was pretreated by steam blanching for 3 min and dried using solar tunnel dryer and minimum WSI content was found in unblanched sun dried.

3.10 Water Absorption Index

The graph below shows that the range of WAI vary from 260.32% to 150.98% for curry leaves. The highest amount of WAI was found in curry leaves which was pretreated by steam blanching for 3 min and dried using solar tunnel dryer and minimum moisture content was found in 0 min using sun drying.

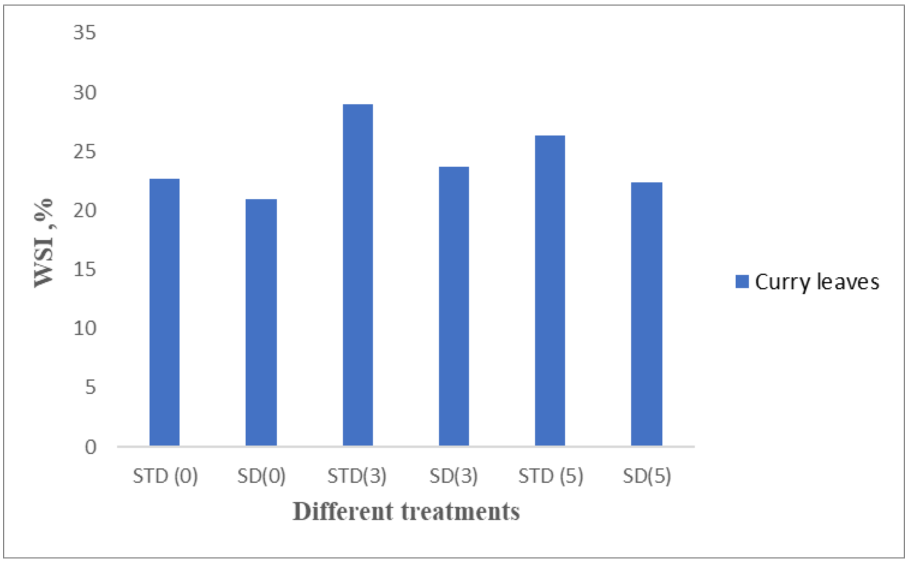

Fig. 9. WSI content of dried powder curry leaves

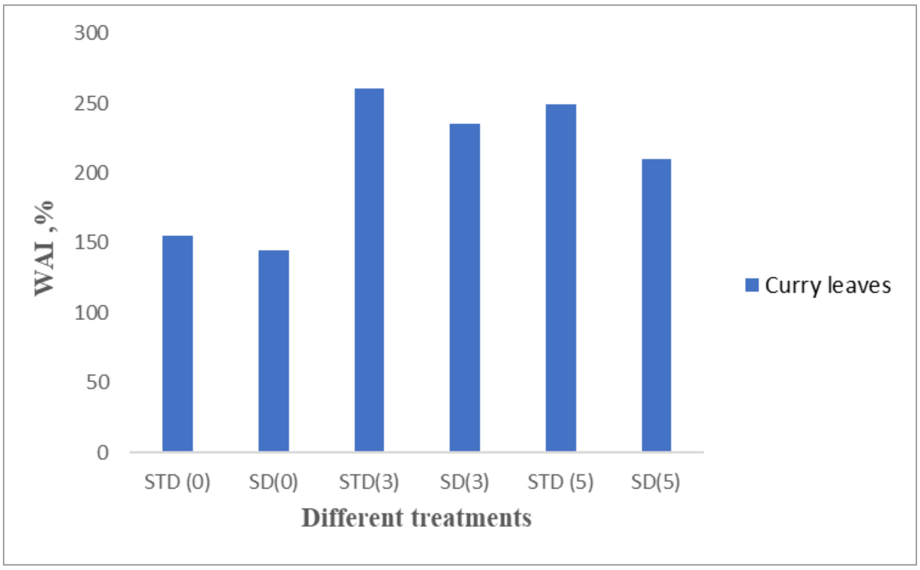

Fig. 10. WAI of dried powder curry leaves

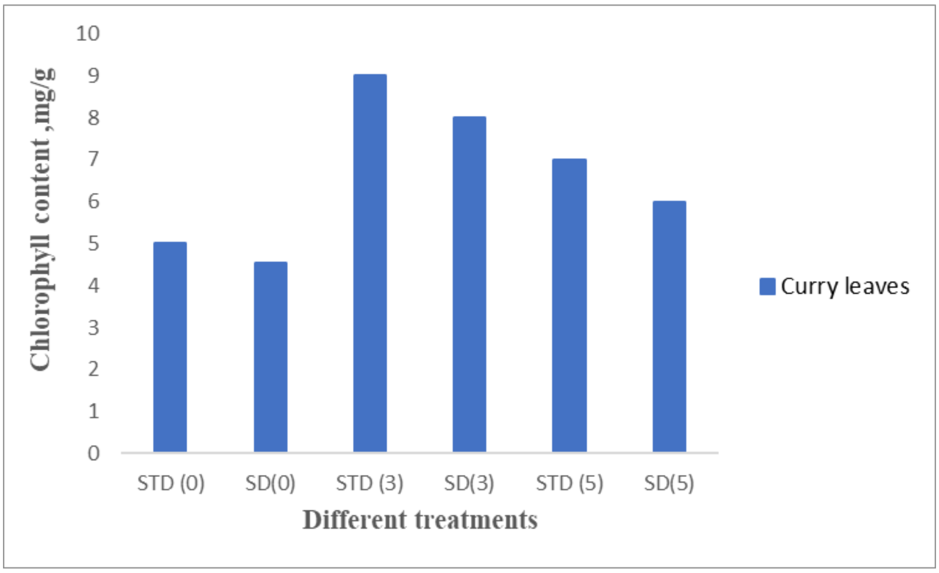

Fig. 11. Chlorophyll content of dried powder curry leaves

3.11 Chlorophyll Content

The graph below shows that the range of chlorophyll content vary from 8.17 to 4.42% for curry leaves. The highest amount of chlorophyll content was found which was pretreated by steam blanching for 3 min and dried using solar tunnel dryer and minimum chlorophyll content was found in unblanched sun dried.

4. SUMMARY AND CONCLUSIONS

The study focused on the physico-chemical and functional properties of both raw leaves and dried leaf powder of curry leaves, which were analyzed under different processing conditions, including varying blanching durations and drying methods. These parameters were determined in the Processing and Food Engineering department of CAET, JAU, Junagadh, using standard analytical methods. The carbohydrate content in curry leaves varied between 43.82% and 54.02%, with the highest content found in leaves pretreated with steam blanching for 3 minutes and dried using a solar tunnel dryer. This suggests that the combination of blanching and solar drying helps preserve carbohydrates more effectively compared to unblanched sun-dried leaves, which exhibited the lowest carbohydrate content. Moisture content ranged from 8.37% to 6.26%, with the highest moisture content observed in unblanched sun-dried leaves. On the other hand, the lowest moisture content was found in leaves blanched for 5 minutes, indicating that blanching, followed by drying, was effective in reducing moisture levels. This finding emphasizes the role of proper blanching and drying techniques in moisture retention and overall quality. Ascorbic acid content, essential for its antioxidant properties, ranged from 2.13% to 2.69%. The highest ascorbic acid content was found in leaves pretreated by steam blanching and dried using a solar tunnel dryer, highlighting that this method helps retain vitamin C content. In contrast, unblanched sun-dried leaves showed the lowest ascorbic acid content, likely due to the degradation of this sensitive nutrient during prolonged sun exposure. The total ash content, which reflects the mineral content of the leaves, ranged from 7.88% to 12.875%. Again, steam blanching followed by solar tunnel drying yielded the highest ash content, suggesting that this method helps preserve or concentrate the mineral content. Unblanched sun-dried samples, conversely, showed the lowest ash content, pointing to a potential loss of minerals due to the sun-drying process. Fat content varied from 5.305% to 4.91%, with the highest fat content recorded in the steam-blanched and solar tunnel-dried leaves. This implies that the drying and blanching process may help retain more lipids in the leaves, which is beneficial for the nutritional profile of the dried powder. Unblanched sun-dried samples had the lowest fat content, which may be attributed to the less efficient drying conditions leading to nutrient loss. Protein content ranged from 10.59% to 9.39%, with the highest protein levels found in the steam-blanched and solar-dried samples. This indicates that blanching and drying preserved the protein content better than sun-drying, which caused a reduction in protein due to the heat and prolonged exposure. Similarly, the fibre content ranged from 12.9% to 8.475%, with the highest fibre content found in the same treatment combination of steam blanching and solar tunnel drying. The unblanched sun-dried leaves had the lowest fibre content, likely due to less efficient drying and potential degradation of fibre. Bulk density, which is an important property for the texture and handling of dried powder, ranged from 451.67 to 385.33 kg/m³. The highest bulk density was observed in the leaves that underwent steam blanching for 3 minutes and solar tunnel drying, indicating that this method resulted in denser leaf powder. In contrast, unblanched sun-dried leaves exhibited the lowest bulk density, likely due to the higher moisture content and uneven drying. Water solubility index (WSI) was found to range from 28.37% to 20.53%, with the highest WSI recorded in the leaves pretreated by steam blanching and dried in the solar tunnel dryer. This suggests that the solar drying method, coupled with blanching, improved the solubility of the dried powder, making it more suitable for rehydration. Unblanched sun-dried leaves had the lowest WSI, which could be due to the formation of insoluble compounds during improper drying. The water absorption index (WAI) ranged from 260.32% to 150.98%. The highest WAI was observed in the leaves pretreated by steam blanching and dried using the solar tunnel dryer, which indicates a better ability of these samples to absorb water compared to the unblanched sun-dried leaves. The lower WAI in the sun-dried samples suggests that the drying method affected the structure of the leaves, reducing their capacity to rehydrate. Finally, chlorophyll content, which is indicative of the freshness and color quality of the leaves, ranged from 8.17% to 4.42%. The highest chlorophyll content was found in the steam-blanched and solar tunnel-dried leaves, which retained more of their green pigment. This suggests that blanching followed by solar drying helps preserve the color and overall quality of curry leaves. In contrast, unblanched sun-dried leaves exhibited the lowest chlorophyll content, likely due to the degradation of chlorophyll during exposure to sunlight. In conclusion, the study highlights the significant influence of blanching and drying techniques on the physico-chemical and functional properties of curry leaves. The combination of steam blanching for 3 minutes followed by drying in a solar tunnel dryer proved to be the most effective treatment in preserving the nutritional content, functional properties, and quality of the leaves. These findings suggest that such processing methods can be optimized for the production of high-quality dried curry leaf powder for food and medicinal applications.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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