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Elevating physiological parameters of coriander powder through cryogrinding temperature variance

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Abstract
Coriander (*Coriandrum sativum* L.) belonging to the Apiaceae family, holds significance is primarily cultivated year-round for its seeds. The economic value of seed spices hinges on their physic-biochemical attributes. This study investigates the impact of cryogenic grinding temperatures (-30 °C, -60 °C, -90 °C) versus ambient grinding on coriander seed powder. Particle size decreases progressively with lower cryogenic temperatures (0.596 mm, 0.523 mm, 0.463 mm for -30 °C, -60 °C, -90 °C, respectively), contrasting with ambient grinding (0.81 mm). Cryo-ground powders exhibit higher bulk densities (565 kg/m³, 688 kg/m³, 754 kg/m³ for -30 °C, -60 °C, -90 °C, respectively) than ambient ground (489 kg/m³), indicating greater compactness. Flowability, measured by angle of repose, decreases with temperature (31º, 28.3º, 25.6º for cryo-ground powders; 34º for ambient). Moisture content diminishes as temperature drops, with cryo-ground powders at -30 °C, -60 °C, -90 °C holding 6.786%, 7.07%, 7.73% moisture, respectively, versus 6.395% for ambient. These findings reveal the intricate correlation between cryogenic grinding and diverse attributes of coriander seed powder, informing potential optimizations for product quality and features.

Keywords: Cryogenic grinding, average particle size, bulk density, angle of repose and moisture content

1. Introduction

Coriander (*Coriandrum sativum* L.), a member of the Apiaceae family, is a prominent aromatic herb widely cultivated for its diverse applications in the food, pharmaceutical (Joshi & Bhatt, 2019) [7] and cosmetic industries. Its two main parts, the foliage known as cilantro and the seeds are valued for their distinct flavor, aroma, and medicinal attributes. This plant has a longstanding history of use across various cultures, and its phytochemical composition, encompassing volatile oils, phenolic compounds, and flavonoids (Sowbhagya & Devaraj, 2016) [16] contributes to its multifaceted properties. Coriander's pharmacological potential, antimicrobial activity (Bakkali *et al.*, 2008) [2] and role as a natural preservative underscore its significance in both traditional and modern contexts. This introduction sets the stage for a comprehensive exploration of *Coriandrum sativum*, drawing insights from scientific literature.

Traditional grinding processes often encounter issues related to heat generation. In contrast, cryogenic grinding involves utilizing extremely low temperatures, achieved by introducing substances such as liquid nitrogen (LN2), to effectively manage excessive heat generation (Ottens, 2012) [12]. This ultra-low temperature renders the material more brittle, leading to finer particle sizes during grinding. This technique not only accelerates the grinding process but also reduces energy consumption. Furthermore, cryogenic grinding helps to mitigate unwanted effects such as browning and color loss due to the application of significantly cold temperatures (Marigo *et al*., 2019) [9]. Cryogenic grinding represents an advanced approach in spice processing, and its adoption remains limited, with only a few establishments in India implementing this innovative method. Keeping in view present investigation on elevating physio-biochemical attributes of coriander powder through cryogrinding temperature variance.

2. Materials and Methods

2.1 Selection of raw material

Coriander seed (Rcr 740) was collected from SKNAU Jobner, Rajasthan. Cleaning of coriander seeds was done to remove the impurities.

2.2 Drying of coriander seed
Drying of whole coriander seed at temperature 35 °C in tray dryer was carried out at Department of Processing and Food Engineering, College of Technology and Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur.

2.3 Cryogenic grinding of dried coriander seed
Cryogenic grinding of dried coriander seed was carried out in Cryogenic grinder machine at Department of Processing and Food Engineering, College of Technology and Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur.

2.4 Variables under study
Variables selected for this study was classified in two major categories as independent variables and dependent variables.

1. Independent variables

Grinding Temperature: 4 levels (-90 °C, -60 °C, -30 °C and ambient temperature).

2. Dependent variables

Physical properties

- Particle size
- Bulk density
- Flowability
- Moisture content

a. Particle size

Sieve analysis is a widely used technique for determining the particle size distribution of materials which holds significant implications for their future applications. In accordance with BSS 460 standards, the ground product underwent sieving using a motorized sieve shaker. Stacked sieves of BSS sieve Nos. 100, 48, 28, 16, 8 and 4, along with a pan and cover were sequentially arranged in the sieve shaker. A 100 g sample of the ground product was carefully placed in the top-most sieve, and the entire set was subjected to shaking for 5 minutes using a sieve shaking machine (Sahay & Singh, 2001) [14]. Upon completion of the shaking process, the material retained in each sieve and the pan was meticulously weighed using an electronic balance with an accuracy of 0.01 g.

Through the application of sieve analysis, the average particle size was determined. The computation of the fineness modulus (FM) and average particle size (Dp) involved the utilization of the following formulae:

$$FM = \frac{(Total\ percent\ retained\ on\ sieve)}{100}$$

$$Dp = 0.135 \times (1.366)^{FM}$$

where, Dp = Average particale size in mm

b. Bulk density

The bulk density of ambient and cryogenically ground coriander seed powder was determined using a container with a known volume. The weight of the container was measured and recorded. Subsequently, coriander seed powder was carefully added to the container without compacting it and the final weight was recorded. To obtain the mass of the coriander seed sample, the weight of the container was subtracted from the combined weight of the coriander seed powder and the container. The bulk density was then calculated using the provided equation:

$$\text{Bulk density} = \text{mass (kg)} / \text{volume (m}^3\text{)}$$

c. Angle of repose

Angle of repose measurements were conducted to evaluate the flow ability of the powder, following the approach outlined by Geldart *et al.* (2012) [6] as presented in table 1. The procedure involved allowing a conical pile of powder to form on a horizontal surface by permitting it to fall from a funnel through a small aperture. To minimize the influence of the fall on the pile tip, the height of the funnel was maintained between 2 and 4 cm from the top of the pile. Precise measurements of the base circle's radius and the height of the pile were taken. The angle of repose will be calculated as:

$$\Theta = \tan^{-1}\frac{2h}{r}$$

Where,
Θ = Angle of repose in degree (o)
H = Height of pile in cm
r = Radius of base circle of pile formed in cm

Table 1: Angle of repose and corresponding flow properties

Angle of Repose (o)	Flow properties
25-30	Excellent
31-35	Good
36-40	Fair
41-45	Passable
46-55	Poor
56-65	Very poor
>66	Very very poor

d. Moisture Content determination

The toluene distillation method for the determination of moisture is applicable to all spices by co-distillation with toluene, with the exception of capsicums, red peppers, paprika, chillies, saffron, dehydrated garlic, onion and dehydrated vegetables. This method is also known as Dean and Stark technique (Pruthi, 1998) [13].

Powder of coriander (40 g, enough to yield 2 to 5 ml water) was placed in a distillation flask. Solvent was added to cover sample completely (not less than 75 ml). The receiving tube was filled with solvent (toluene), pouring through top of condenser. Loose cotton plug was inserted through the top of the condenser to prevent condensation of atmosphere moisture in the tube. The flask was heated to boil and distill slowly at the rate of 2 drops/sec, until most of water distilled over. Then, the rate of distillation was increased to about 4 drops/sec. The distillation was continued till two consecutive readings at 15 minutes intervals, showed no change. There was any water held upon in condenser it was removed with brush of wire loop. The condenser was rinsed carefully with about 5 mL toluene. Distillation was continued for 3 to 5 minutes, after which the receiver was cooled to room temperature (about 25 °C) by immersing it in water. Solvent and water layers became clear. The volume of water collected was noted to the nearest 0.01 mL and the moisture content (percent) was calculated on wet as well as dry basis using the following equations, respectively. The moisture content (percent) was calculated on wet as well as dry basis using the following equations, respectively.

Moisture content (% wet basis) = [V w /Ws] * 100
Moisture content (% dry basis) = [V w /(Ws- V w)] * 100
Where Vw is volume of water (mL) and Ws is weight of sample (g). The reported values were the mean of triplicate observations.

2.5 Statistical Analysis
The statistical analysis of data was performed in JMP software version 12 (SAS, 2010) to find out statistical significance (p=0.05) among treatments. To assess the potential impact of different temperature levels on the quality of the cryo-ground coriander seed powder.

3. Results and Discussion
3.1 Particle size
The average particle size of cryo-ground coriander seed powder at temperatures -30 °C, - 60 °C, -90 °C was observed 0.596mm, 0.523mm and 0.463mm respectively, the average particle size of ambient ground coriander seed powder was found to be 0.81mm (Fig.1). Coriander seed powder ground using a cryogenic process was finer than coriander seed powder ground using a hammer mill. It indicates that there is increase in the bulk density for coriander seed with decrease in grinding temperature. Similar results were shown in the research works done by Murthy (2001) [11].

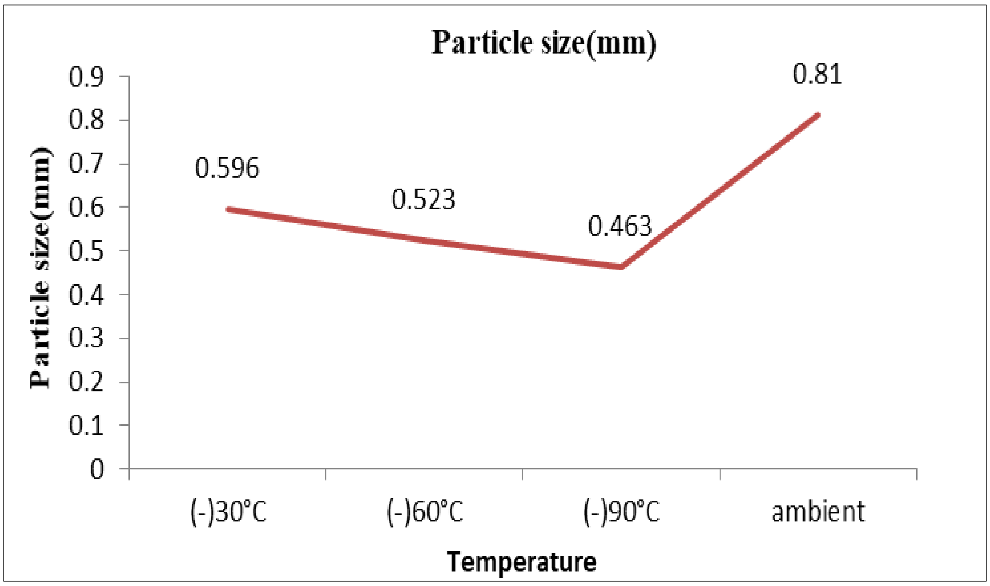

Fig 1: Variation in Particle size of coriander seed powder ground at different temperatures

3.2 Bulk density
The bulk density of cryo-ground coriander seed powder at temperatures -30 °C, -60 °C, - 90 °C was observed 565, 688 and 754 kg/m3 respectively; the bulk density of ambient ground coriander seed powder was found to be 489 kg/m^3 (Fig. 2). It indicates that there is increase in the bulk density for coriander seed with decrease in grinding temperature.

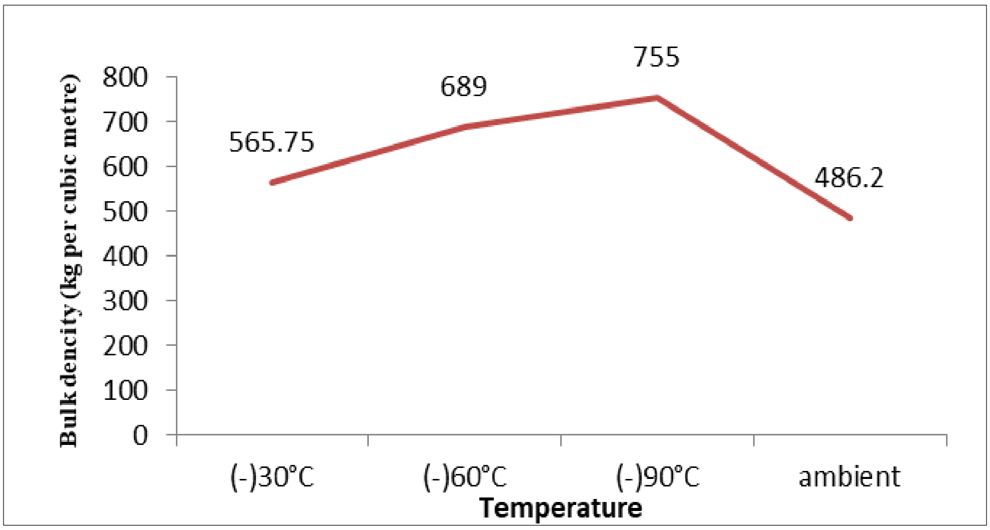

Fig. 2 Variation in Bulk Density of coriander seed powder ground at different temperatures

3.3. Angle of repose

The angle of repose of coriander seed powder for cryo-ground temperatures -30 °C, -60 °C and -90 °C was observed to be 31º, 28.3º and 25.6º respectively; the value of angle of repose of ambient ground coriander seed powder was found to be 34º (Fig. 3). I.e. angle of repose increased with increase in grinding temperature due to increase in cohesiveness and sticky nature at higher temperatures. The angle of repose is an important parameter in designing hopper openings. When the angle of repose is less than 25º, the flow is said to be excellent; on the other hand, if the angle of repose is more than 40o, the flow is considered to be poor (Edward Lau, 2001) [5].

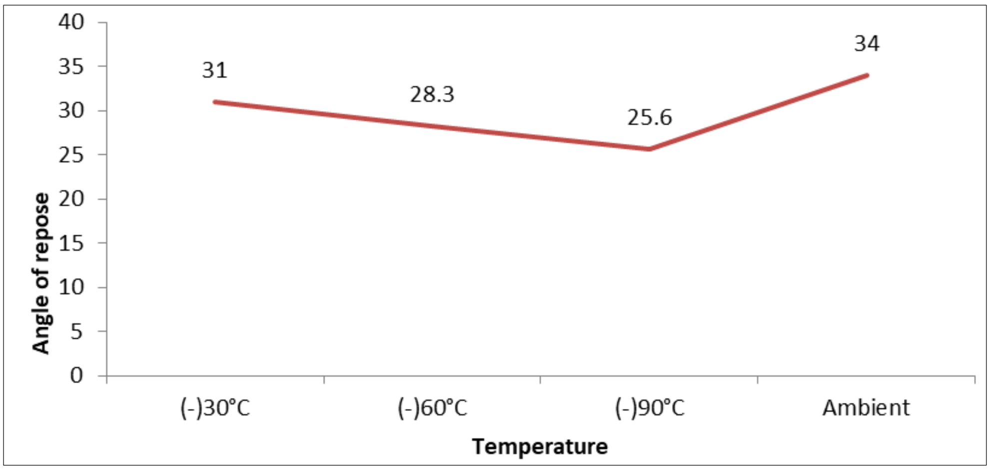

Fig 3: Variation in Angle of repose of coriander seed powder ground at different temperatures

3.4 Moisture content

The moisture content of coriander seed powder for cryo-ground temperatures -30 °C, -60 °C and -90 °C was observed to be 6.786, 7.07 and 7.73 % respectively; the value of moisture content of ambient ground coriander seed powder was found to be 6.395 (Fig. 4) i.e. moisture content decrease with increase in grinding temperature due to increase temperature. Meghwal and Goswami (2014) [10] have documented similar findings in their research. They concluded that the study on moisture analysis revealed slight variations in the moisture content when comparing samples before and after grinding. The potential reason for these minor differences lies in the temperature changes during the grinding process. In ambient grinding, there might be a decrease in moisture due to the rise in temperature, whereas in cryogenic grinding, there could be a slight increase in powder moisture. This increase is attributed to the absorption of humidity (85 to 90%) from the surroundings, which maintain a very low temperature (−130 to −150 °C). These observations provide practical insights for industries dealing with coriander powder, suggesting possible implications for shelf stability, microbial activity, and overall quality.

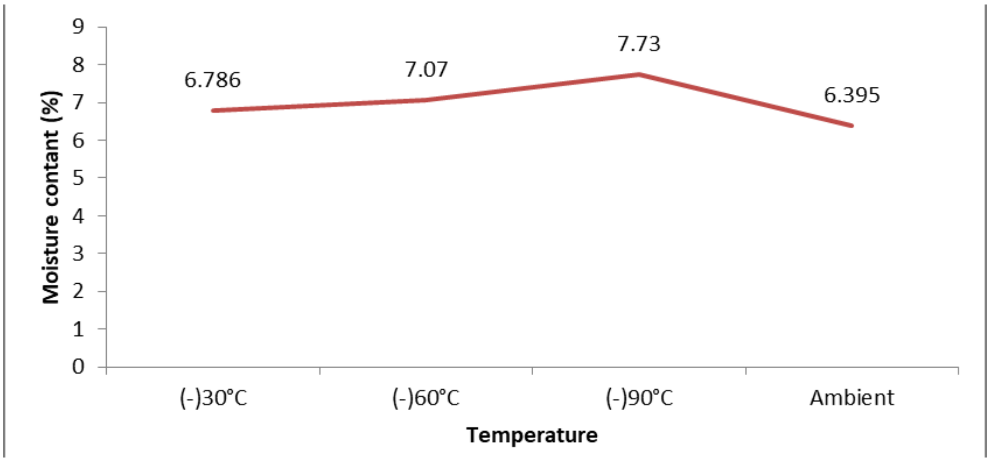

Fig. 4 Variation in Moisture content of coriander seed powder ground at different temperatures

Table 2: Effect of different grinding temperatures on physical properties of coriander seed powder

Temperature	Particle size(mm)	Bulk density(kg/m^3)	Angle or response	Moisture %
Ambient grinding	0.81 ± 0.04 ^{a}	489 ± 1^d	34 ± 1^a	6.395 ± 0.05^c
-30 °C	0.596 ± 0.008^b	565 ± 7.637^c	31 ± 0.577^b	6.786 ± 0.02^c
-60 °C	0.523 ± 0.008^c	688 ± 4.618^b	28.3 ± 0.33^c	7.07 ± 0.09^b
-90 °C	0.463 ± 0.008^c	754 ± 3.055^a	25.6 ± 0.33^d	7.73 ± 0.12^a

Each value is mean three replicates. Mean ± SE (standard error) followed by same latter is not significantly different at p = 0.05 as determined by turkey-kramer HSD test

4. Conclusion

In conclusion, the investigation into coriander powder's properties under different grinding temperatures has yielded significant insights into particle size, bulk density, angle of repose, and moisture content. The particle size analysis revealed a clear correlation between lower grinding temperatures and finer particle sizes, with the smallest size achieved at -90 °C. Bulk density exhibited a systematic increase with decreasing grinding temperatures, reaching its peak at -90 °C. The angle of repose consistently decreased as the grinding temperature decreased, indicating improved cohesiveness and reduced flow ability in cryogenic grinding compared to ambient conditions.

Furthermore, the moisture content analysis demonstrated a temperature-dependent pattern, showcasing an incremental rise in moisture content as grinding temperature decreased. Notably, coriander powder ground at lower temperatures retained more moisture compared to ambient grinding conditions. These findings provide valuable insights for industries involved in coriander powder processing, offering considerations for particle size control, bulk density optimization, and understanding the impact of grinding temperatures on moisture content. Implementing these insights can contribute to enhanced product quality and process efficiency in the coriander powder industry.

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6. Reference

1. Amin I, Norazaidah Y, Hainida KIE. Antioxidant activity and phenolic content of raw and blanched Amaranthus species. Food Chemistry. 2006;94:47-52. https://doi.org/10.1016/j.foodchem.2004.11.007
2. Bakkali F, Averbeck S, Averbeck D, Idaomar M. Biological effects of essential oils-a review. Food and Chemical Toxicology. 2008;46(2):446-475. https://doi.org/10.1016/j.fct.2007.09.106
3. Chang C, Yang M, Wen H, Chern J. Estimation of total flavonoid content in propolis by two complementary colorimetric methods. Journal Food Drug Analysis. 2002;10:178-182. https://www.food.org.tw/NSYSU/10-3/NSYSU-10(3)-14.pdf
4. Chen Z, Zhang X, Wang L. A review on cryogenic grinding. International Journal of Refrigeration. 2019;106:87-97. https://doi.org/10.1016/j.ijrefrig.2019.05.014
5. Edward L. Reformulations studies. Separation Science and Technology. 2001;3:173-233. https://doi.org/10.1081/SS-100000559
6. Geldart D, Abdullah EC, Hassanpour A, Nwoke LC, Wouters I. Characterization of powder flowability using measurement of angle of repose. China Particuology. 2012;4:104-107. https://doi.org/10.1016/j.cpart.2005.08.002
7. Joshi AR, Bhatt ID. *Coriandrum sativum* L.: A potential source of high-value components for functional foods and nutraceuticals-a review. Phytochemistry Reviews. 2019;18(5):1349-1373. https://doi.org/10.1007/s11101-019-09640-2
8. Manohar B, Sridhar BS. Size and shape characterization of conventionally and cryogenically turmeric (Curcuma Domestica) particles. Powder Technology. 2001;12:292-297. https://doi.org/10.1016/S0032-5910(01)00445-2
9. Marigo A, Dolci LS, Pinotti L, Baldi G. The effects of freezing on the quality of ground beef: A review. Italian Journal of Food Science. 2019;31(2):191-209. https://doi.org/10.14674/IJFS-1002
10. Meghwal M, Goswami TK. Comparative study on ambient and cryogenic grinding of fenugreek and black pepper seeds using rotor, ball, hammer and Pin mill. Powder Technology. 2014;267:245-255. https://doi.org/10.1016/j.powtec.2014.06.076
11. Murthy CT, Krishnamurthy N, Ramesh T, Srinivisa PN. Effect of Grinding Methods on the Retention of Black Pepper Volatiles. Journal of Food Science and Technology. 2001;33(4):299. https://doi.org/10.1007/BF02826257
12. Ottens M. Cryogenic grinding: An independent voice. Chemical Engineering Progress. 2012;108(9):22-25. https://aiche.onlinelibrary.wiley.com/doi/abs/10.1002/cepr.201200052
13. Pruthi JS. Quality Assurance in Spices and Spice Products: Modern Methods of Analysis. New Delhi, India: Allied Publisher Ltd; 1988.
14. Sahay KM, Singh KK. Unit operations of agriculture processing. Vikash Publishing House Private Limited; 2001.
15. Saxena R, Saxena SN, Barnwal P, Rathore SS, Sharma YK, Soni A. Estimation of antioxidant activity, phenolic and flavonoid content of cryo and conventionally ground seeds of coriander (*Coriandrum sativum* L.) and fenugreek (*Trigonella foenum-graecum* L.). International Journal Seed Spices. 2012;2(2):83-86.
16. Sowbhagya HB, Devaraj R. Antioxidant activity of selected Indian spices. Procedia Food Science. 2016;6:234-239. https://doi.org/10.1016/j.profoo.2016.02.037