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Effect of Temperature in Cryo-grinding on Physio-chemical Parameters of Turmeric Powder

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ABSTRACT: One of the most significant spices from India is turmeric (*Curcuma longa L.*). India is the top producer of turmeric in the world, and within the nation, Andhra Pradesh leads the pack, followed by Tamil Nadu, Odisha and Karnataka. Natural antioxidants found in turmeric are abundant, and it also has anti-oxidant, anti-viral, anti-protozoal, and anti-carcinogenic qualities. Turmeric must be ground into a useful form before it can be used, but this process unfortunately raises the product's temperature, which results in the loss of essential ingredients such as volatile oil, curcumin, flavouring compounds, and colour. Because more heat is lost during grinding, an increase in temperature also causes sieves to clog and results in excessive power consumption. To remedy this issue, the cryogenic grinding system has been used. By cooling the spices with liquid nitrogen and maintaining the right low temperature by absorbing the heat produced during the grinding process, this approach can significantly reduce the loss of important components like curcumin. Dry turmeric was cryogenically ground at temperatures of -30°C, -50°C, -70°C and grinding at ambient temperature was used as control. The results showed that curcumin content was preserved at a higher level in the ground sample 3.71% at -70°C while the lowest level was 3.19% at ambient grinding. The lowest and greatest L values were discovered to be 63.77 at ambient ground powder and 66.15 at -70°C, respectively. The brightness is indicated by the L value. When used with turmeric, cryogenic grinding is a beneficial technology that creates a powder with good grinding capabilities and far less quality deterioration.

KEYWORDS: Cryogenic grinding, Curcumin, Antioxidants, Colour, Ambient temperature.

I. INTRODUCTION

India and Southeast Asia are home to the zingiberaceae plant family, which includes turmeric (*Curcuma longa linn*). India is the world's top producer and exporter of turmeric. India produces almost all of the turmeric crop in the world and uses 80% of it. Indian turmeric is regarded as the greatest in the world due to its natural properties and high level of the significant bioactive component curcumin. Turmeric is said to have many medical benefits, including antioxidant and anti-protozoal actions, and it includes natural antioxidants (Tuba and Ilhami, 2008). The curcuminoids, which comprise curcumin, demethoxycurcumin, and bis-demethoxycurcumin, are the primary physiologically active components of turmeric. The yellow phenolic pigment curcumin, which accounts for 2% to 5% of the spice, is a powerful antioxidant that can remove superoxide radicals, hydrogen peroxide, and nitric oxide from activated macrophages.

The study of extremely low temperatures and their use on various materials, including biological products, is known as cryogenics. There are several uses for cryogenics in fields such as biology, agriculture, electronics, automotive, manufacturing, sports, and space science. The use of cryogenic freezing in food, specifically in spices and condiments, is crucial. Although a broad variety of cryogens are available to achieve the requisite low temperature, liquid nitrogen (N₂(l)) is typically utilised in food grinding. The use of low temperature offers a possible route to producing final products of superior quality with greater flavour and volatile oil retention. Higher cooling rates, throughput, versatility in terms of accepting diverse goods, and superior quality with lower capital cost and dehydration loss are only a few of the special advantages offered by cryogenic technology. Fruits and vegetables, meat, seafood and other high-value frozen foods can now be produced using cryogenic technology.



II. METHODOLOGY

This chapter describes the experimental setup, methodologies, and procedures used to accomplish the current investigation. This covers the description of the raw material, estimation of the moisture content, experimental setup, methods for grinding turmeric, and evaluation the quality of ground turmeric.

2.1 Selection of Raw Material

Turmeric rhizomes were collected from local market of Udaipur, Rajasthan. The turmeric rhizomes were cleaned to remove adhering impurities.

2.2 Drying of Turmeric Rhizomes

Drying of sliced turmeric rhizomes 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 Turmeric Rhizomes

Cryogenic grinding of dried turmeric rhizomes was carried out 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.

2.4.1 Independent variables

- Temperature levels: -70°C, -50°C, -30°C and ambient temperature (23°C)

2.4.2 Dependent variables

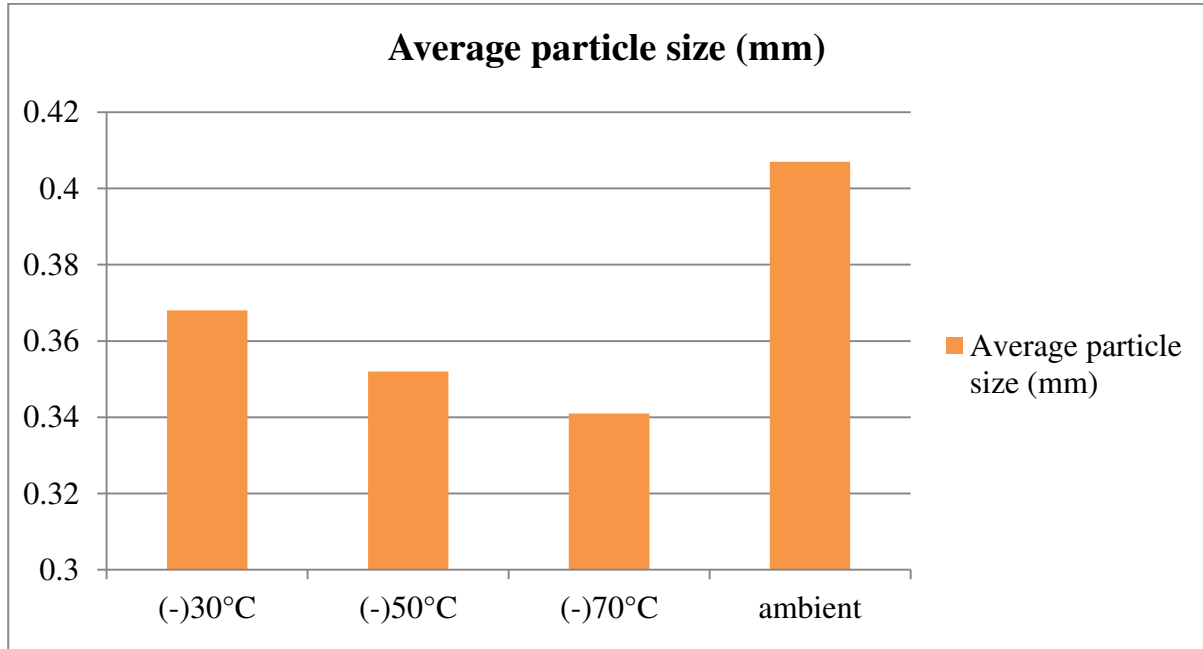
- Particle size
- Bulk density
- Angle of repose
- Quality evaluation
 - Water activity
 - Colour
 - Curcumin content

III. EXPERIMENTAL RESULTS

This chapter deals with the results of the investigation carried out on grinding of turmeric samples. The effect of grinding methods on the quality *i.e.* particle size, bulk density, angle of repose, water activity, color value and curcumin content of the turmeric powder has been presented and discussed here under.

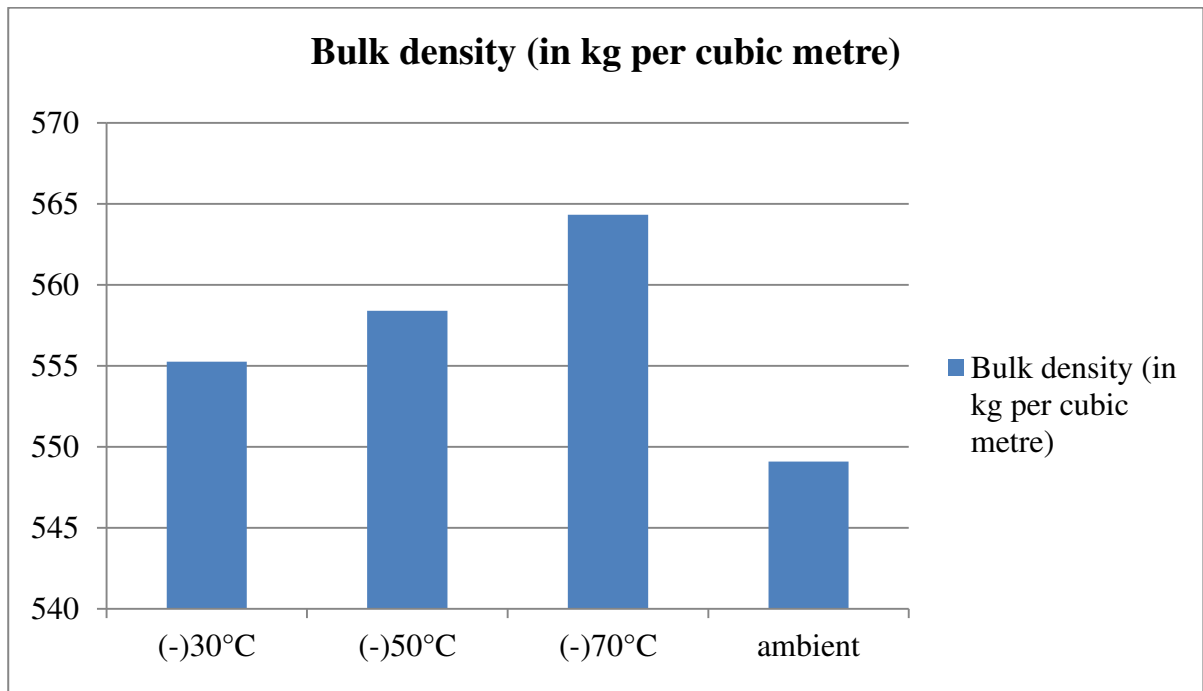
3.1 Particle size

The average particle size of cryo-ground turmeric powder at temperatures -30°C, -50°C, -70°C was observed 0.368mm, 0.352mm and 0.341mm respectively; the bulk density of ambient ground turmeric powder was found to be 0.407mm. It indicates that the increase in bulk density for turmeric with decrease in grinding temperature.



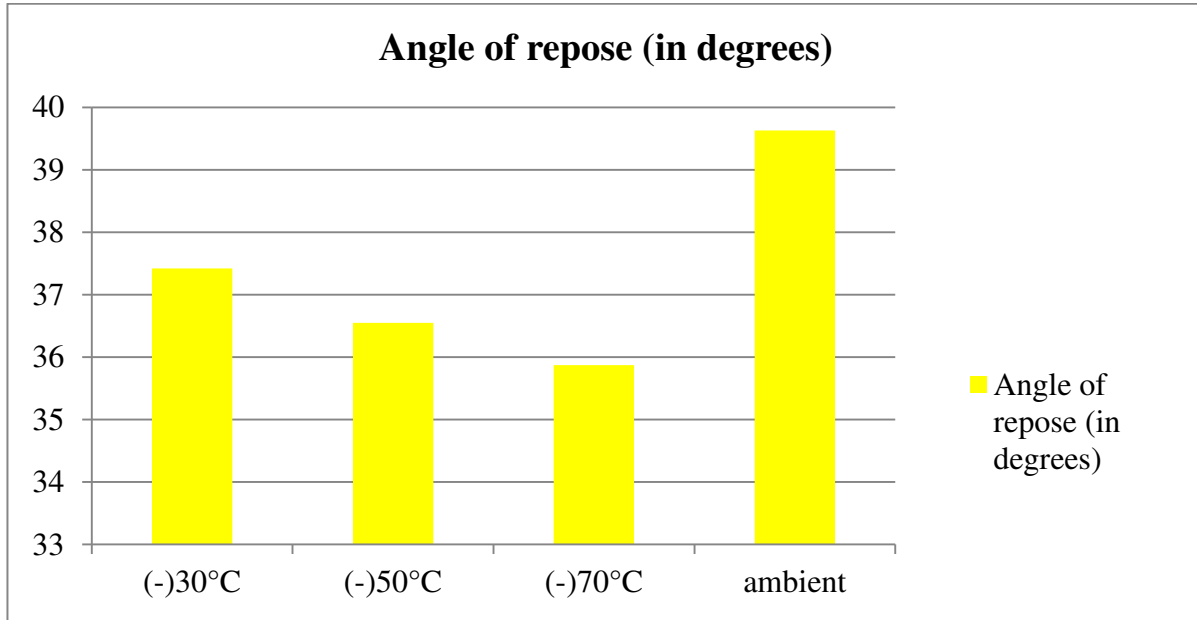
3.2 Bulk density

The bulk density of cryo-ground turmeric powder at temperatures -30°C, -50°C, -70°C was observed 555.25, 558.40 and 564.33 kg/m³ respectively; the bulk density of ambient ground turmeric powder was found to be 549.09 kg/m³. It indicates that the increase in bulk density for turmeric with decrease in grinding temperature.



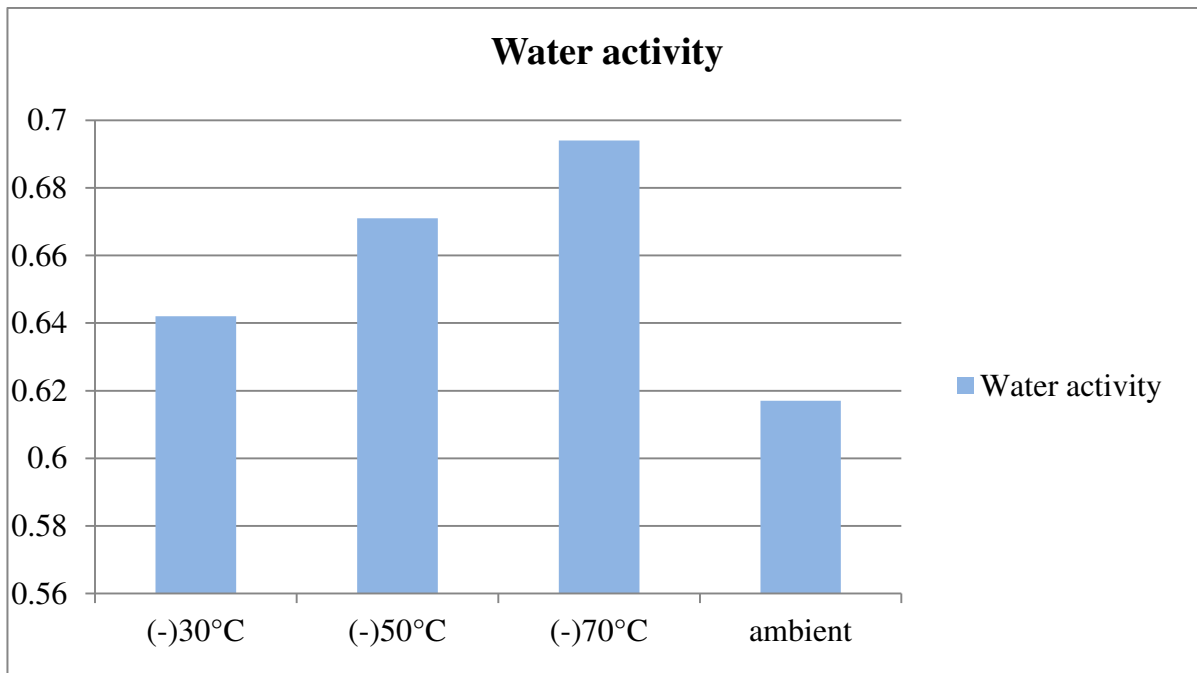
3.3 Angle of repose

The angle of repose of turmeric powder for cryo-ground temperatures -30°C, -50°C and -70°C was observed 37.42°, 36.55° and 35.87° respectively; the value of angle of repose of ambient ground turmeric powder was found to be 39.63°, i.e. angle of repose increased with increase in grinding temperature.



3.4 Water activity

Water activity was determined as a measure of storage stability using a digital water activity meter for all samples. Water activity is related to moisture content and all samples in this study were set to reach safe level of final moisture content, so the results did not show any difference in water activity. The water activity for temperatures -30°C, -50°C, -70°C were found to be 0.642, 0.671 and 0.694 respectively. The water activity of ambient ground powder was found to be 0.617.

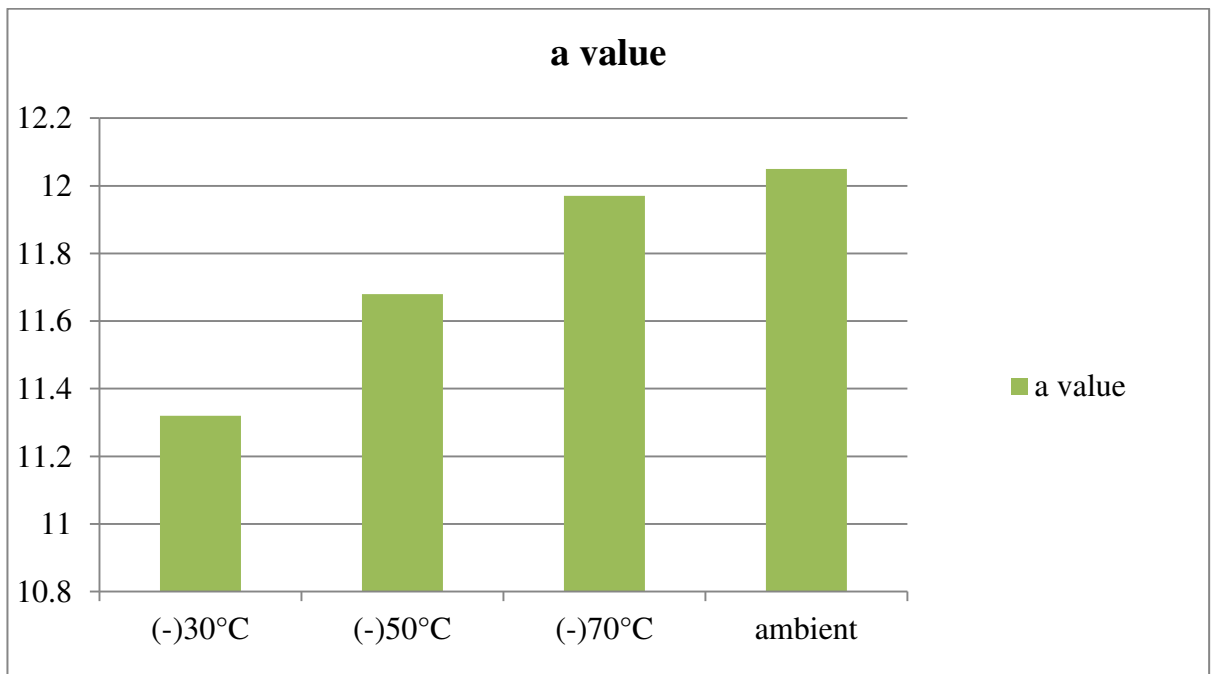
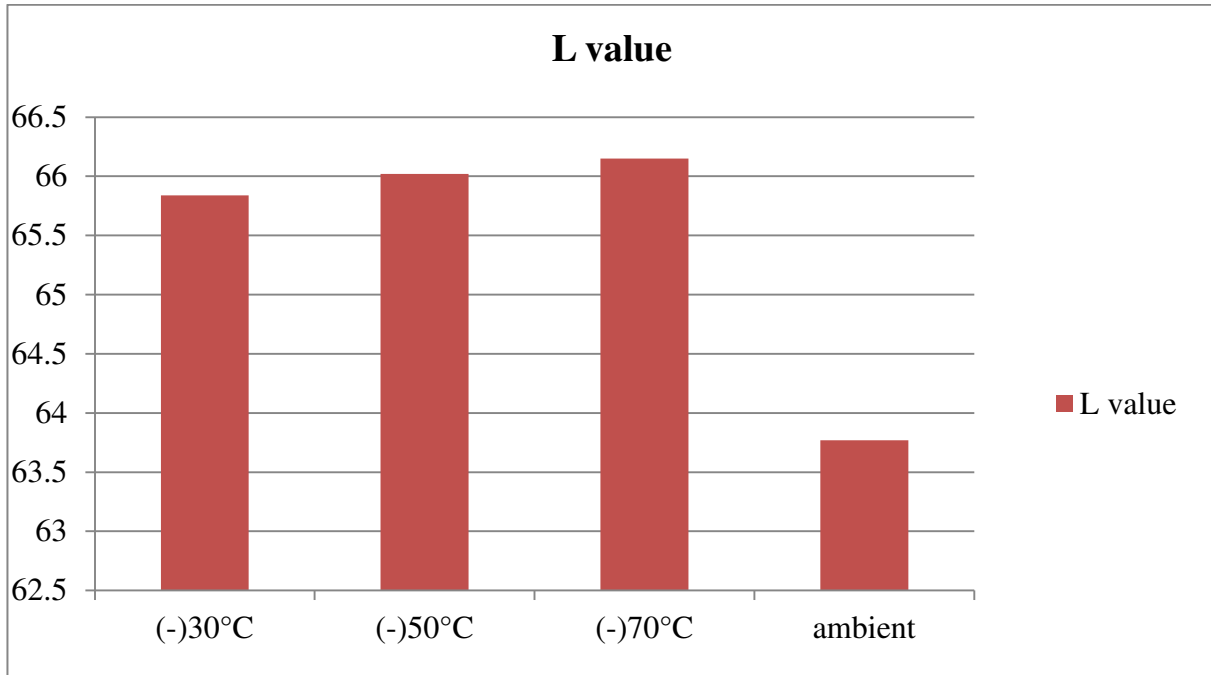


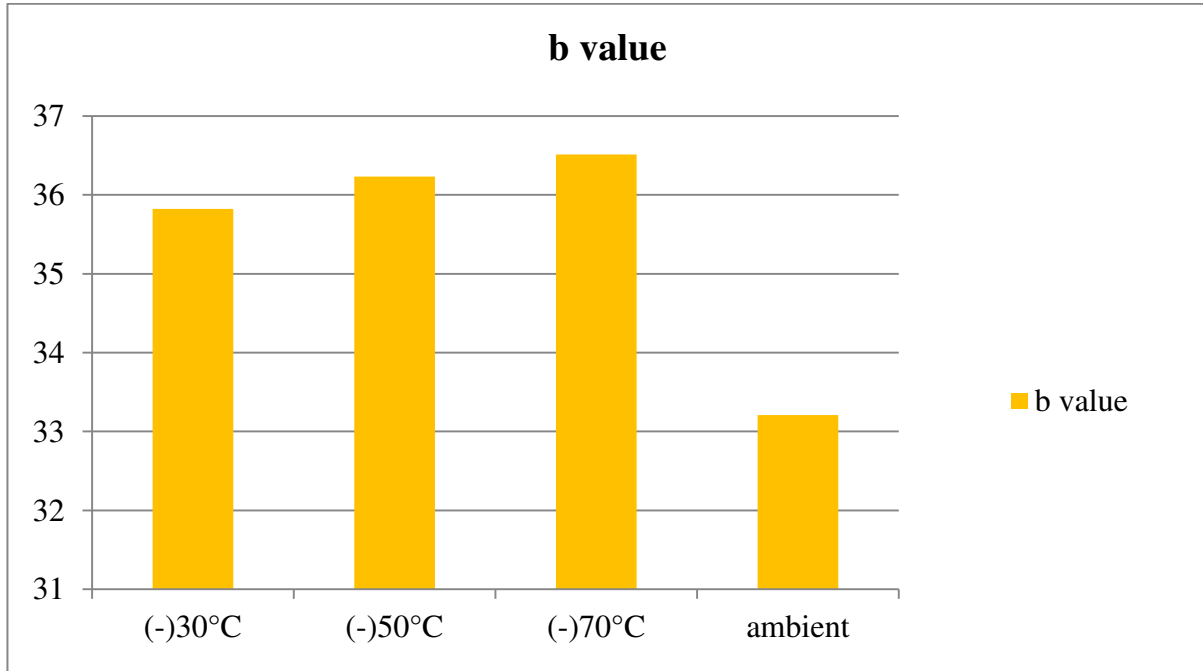
3.5 Colour

Color plays an important role in indicating quality of product. Colour values (L, a, b) of turmeric powder was obtained. It was observed that the value of L at temperatures -30°C, -50°C and -70°C was found 65.84, 66.02 and 66.15 respectively; value of a at temperatures -30°C, -50°C and -70°C was found 11.32, 11.68 and 11.97 respectively; value



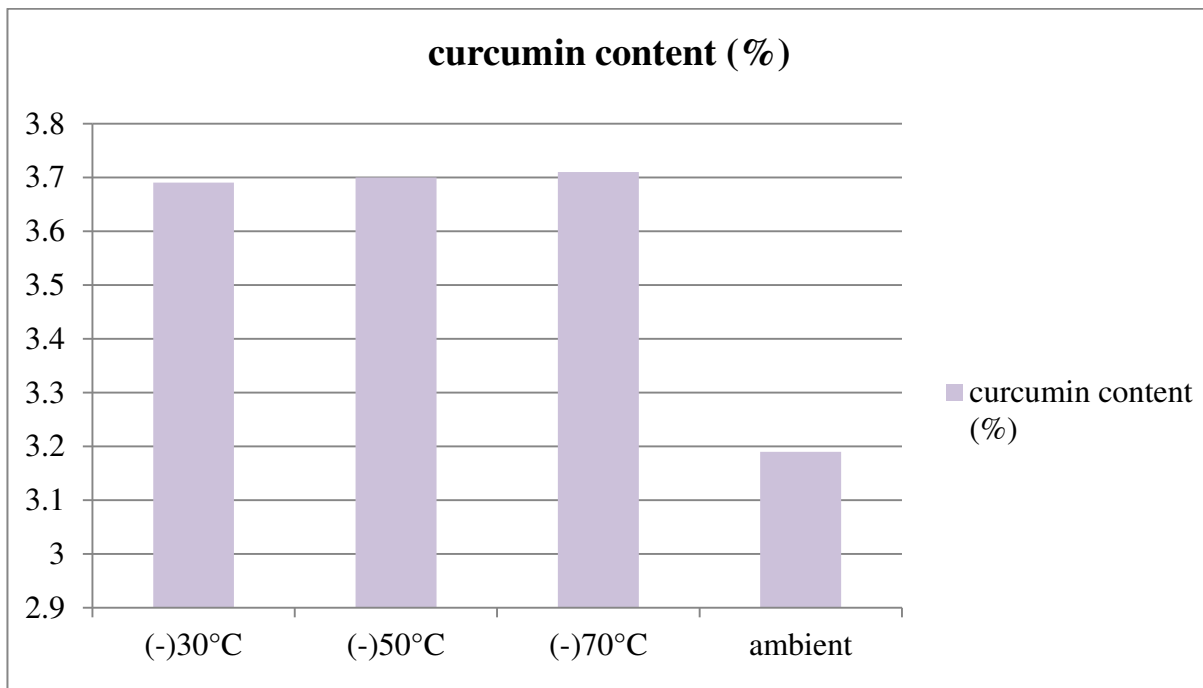
of b at temperatures -30°C, -50°C and -70°C was found 35.82, 36.23 and 36.51 respectively. The L, a and b values of ambient ground powder was found to be 63.77, 12.05 and 33.21 respectively.





3.6 Curcumin content

It is important quality parameter to decide commercial value and medicinal value of turmeric in local and export market. The curcumin content of cryo-ground turmeric powder was found to be $3.71 \pm 0.02\%$ and the curcumin content of ambient ground turmeric powder was found to be $3.19 \pm 0.02\%$. It was observed that curcumin content of cryo-ground turmeric powder was significantly higher than ambient ground turmeric powder.





IV. CONCLUSION

1. The particle size of turmeric powder was in the range of 0.341mm to 0.407mm. The higher grinding temperature, the particle size was large. Similarly, at a low temperature of grinding the average particle size was also small.
2. The powder produced by ambient grinding and cryogenic grinding had bulk densities in the range of 549.09 kg/m³ to 564.33 kg/m³, respectively. The bulk density increased with the decrease in grinding temperature. Cryo-turmeric powder was found to higher bulk density than ambient ground powder.
3. At -70°C, the angle of repose is lowest, while at ambient conditions, it is highest. The angle of repose values ranged from 35.87 degrees to 39.63 degrees. This range of flowability places a powder in the 'Good' and 'Fair' category.
4. The lowest and greatest L values were discovered to be 63.77 at ambient grinding and 66.15 at -70°C, respectively. 12.05 at ambient temperature and 11.32 at -30°C were found to be the highest and lowest a values, respectively. The highest value of a at the ambient ground and the lowest at -30°C. The yellowness of the powder is indicated by the b value. For a grinding temperature of -70°C, the maximum value was found to be 36.51. The lowest value found was 33.21 at ambient grinding.
5. The highest and lowest percentages of curcumin content found were 3.71% and 3.19%, respectively. A grinding temperature of -70°C yielded the maximum amount of curcumin, while a normal grinding temperature yielded the lowest amount.
6. The water activity of turmeric powder was in the range of 0.617 to 0.694. The higher grinding temperature, the water activity was low. Similarly, at a low temperature of grinding the water activity was also high.

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