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# Effect of Temperature in Cryo-grinding on Physio-Chemical Parameters of Garlic Powder

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**ABSTRACT:** Garlic is a well-liked spice in India that is utilised in both cooking and conventional treatment. Garlic has the capacity to provide humans with two thirds of their daily Vitamin-C requirements. The previous method of powdering or grinding garlic using a hammer mill raised the product's temperature, which led to the loss of allicin content, vitamin-C content, and colour value. To resolve this issue, the cryogenic grinding system has been used. By cooling the spices with liquid nitrogen and maintaining the low temperature by absorbing the heat created during the grinding process, this approach can significantly reduce the loss of important components like allicin and vitamin-C content. Cryogenically grinding of dried garlic at -30°C, -60°C, and -90°C was done, with ambient temperature serving as the reference. According to the results, allicin content was preserved at a higher level in the ground sample at -90°C, where it was 9.16 mg/g of dry mass, compared to ambient grinding, where it was 7.21 mg/g of dry mass. The vitamin-C concentration was determined to be 20.11 mg/100g of dry matter for ambient grinding and 26.74 mg/100g of dry matter for cryogenic grinding at -90°C. Therefore, at lower grinding temperatures, the vitamin-C concentration was higher. The results showed that the lowest and highest L values were, respectively, 71.83 at ambient ground powder and 74.13 at -90°C. The L Value reveals the brightness. When used for garlic, cryogenic grinding is a beneficial technology that yields a powder with good grinding qualities and minimal quality damage.

**KEYWORDS:** Cryogenic Grinding, Allicin content, Vitamin-C, Ambient grinding, Brightness, Liquid Nitrogen.

## I. INTRODUCTION

India accounts for 50% of global trade and is the leading producer, consumer, and exporter of spices in the world. Indian spices are renowned for their exquisite flavour, perfume, and medicinal properties. Between 80% and 85% of the nation's entire spice production is consumed domestically. Any spice's intrinsic and extrinsic characteristics can be used to assess its quality.

*Allium sativum* is the scientific name for garlic, a plant that belongs to the lily family. One of the earliest plants to be cultivated, garlic presumably originated in central Asia. In addition to being a food, garlic has long been utilised as a folk medicinal plant. Garlic is still used in folk medicine around the world today to cure a range of illnesses. Garlic's health benefits are linked to its phenolic elements, particularly flavonoids, and a number of organosulfur compounds. Numerous active substances found in garlic, including allicin, polysaccharides, and polyphenols, are responsible for the plant's distinctive flavour and biological activity. Spices are often ground using hammer mills, plate mills, ball mills, pin mills, and roller mills. Only 1% of the entire energy input is used to reduce particle size in the energy-intensive process of grinding, and the remaining energy is lost as heat. Products can reach 90°C in ambient grinding (Bera *et al.*, 2011), 40°C in wet grinding (Jung *et al.*, 2018) and 26°C in freeze grinding were observed (Mathew and Sreenarayanan, 2007). The study of extremely low temperatures and their use on various materials, including biological products, is known as cryogenics. The superior grade ground powder obtained by grinding spices at a very low temperature has greater cleanliness. Cryogenic grinding of herbs and spices not only preserved the volatiles without a loss but also preserved the originality in flavour quality, which has potential commercial applications. Although a broad variety of cryogens are available to achieve the requisite low temperature, liquid nitrogen (N<sub>2</sub>(l)) is typically utilized in food grinding.



## II. METHODOLOGY

This covers the description of the raw material, estimation of the moisture content, experimental setup, methods for grinding garlic, and evaluation the quality of ground garlic.

Selection of raw material:- Garlic cloves was collected from local market of Udaipur, Rajasthan. Cleaning to remove impurities and peeling of garlic cloves was done manually.

Drying of garlic cloves:- Drying of whole garlic cloves was carried out at Department of Processing and Food Engineering, College of Technology and Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur.

Cryogenic Grinding of Dried Garlic Cloves:- Cryogenic grinding of dried garlic cloves was carried out in Department of Processing and Food Engineering, College of Technology And Engineering, Maharana Pratap University of Agriculture and Technology, Udaipur.

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

Independent variables:- Temperature: 4 levels(-90 °C, -60 °C, -30 °C and ambient temperature 22°C)

Dependent variables:-

Particle size

Angle of repose

Quality evaluation

Water activity

Ascorbic acid content

Color

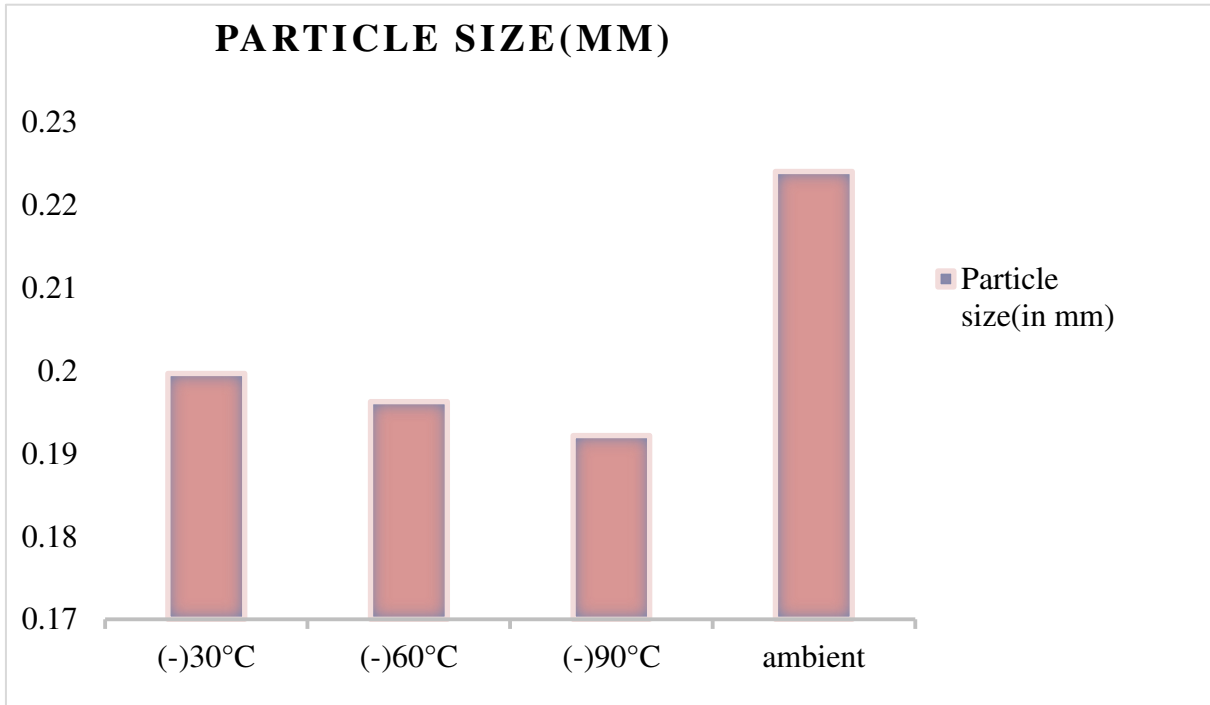
Allicin content

## III. EXPERIMENTAL RESULTS

This chapter deals with the results of the investigation carried out on grinding of garlic samples. The effect of grinding methods on the quality i.e. water activity, color value, vitamin-C and allicin content of the garlic powder has been presented and discussed here under.

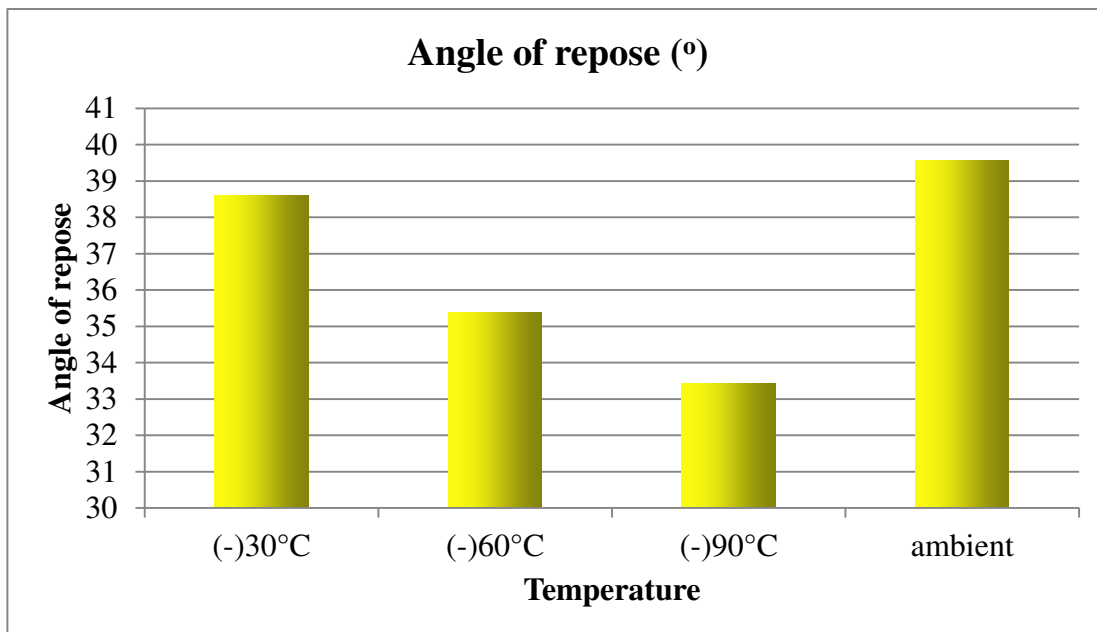
### ● Particle size

The average particle size of cryo-ground garlic powder at temperatures -30°C, -60°C, -90°C was observed .1997mm, .1972mm and .1970mm respectively; the average particle size of ambient ground garlic powder was found to be .2241mm. It indicates that there is increase in the bulk density for garlic with decrease in grinding temperature.



● Angle of repose

The angle of repose of garlic powder for cryo-ground temperatures -30°C, -60°C and -90°C was observed 38.61°, 35.57° and 33.43° respectively; the value of angle of repose of ambient ground garlic powder was found to be 39.56°, i.e. angle of repose increased with increase in grinding temperature. The angle of repose is an important parameter in designing hopper openings.

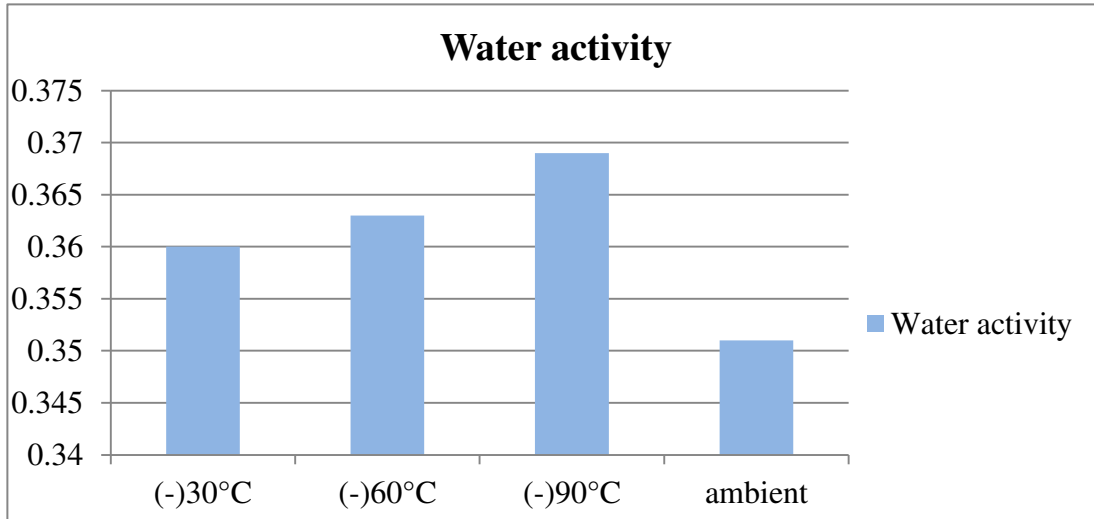


● Quality evaluation

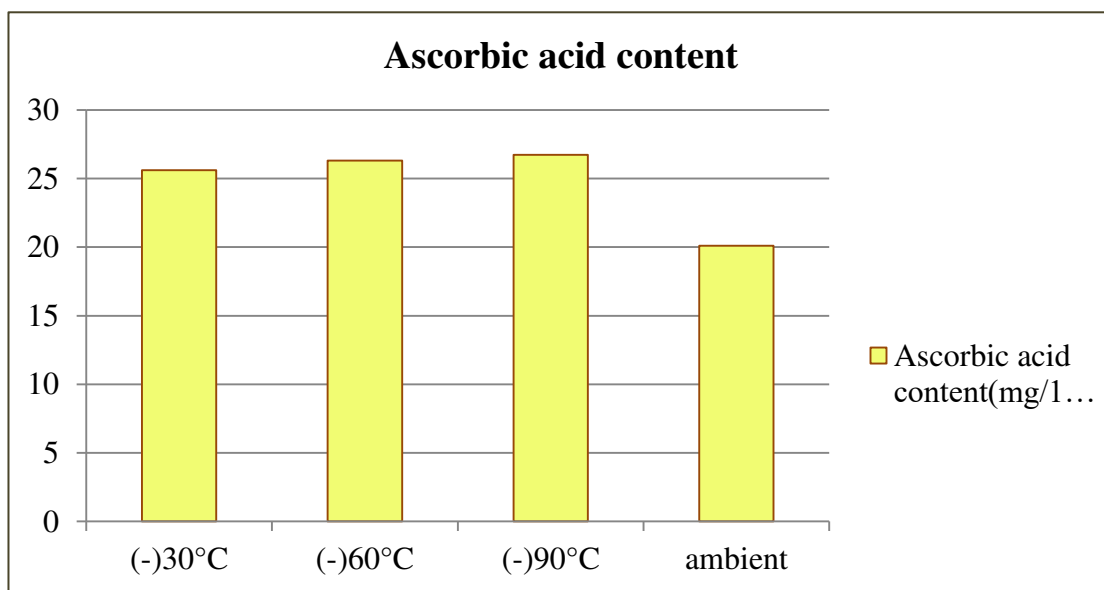
1. Water activity:- Water activity which tells about storage stability was determined using a digital water activity meter for all samples. Water activity is related to moisture content and all samples in this study were set to



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, -60°C, -90°C were found to be 0.36, 0.363 and 0.369 respectively. The water activity of ambient ground powder was found to be 0.351.



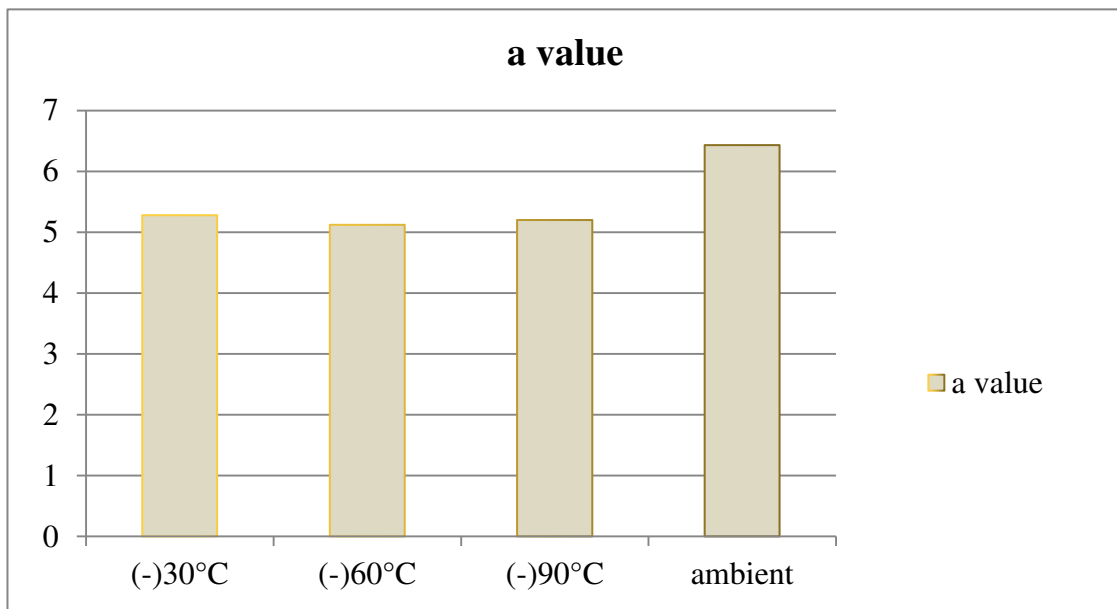
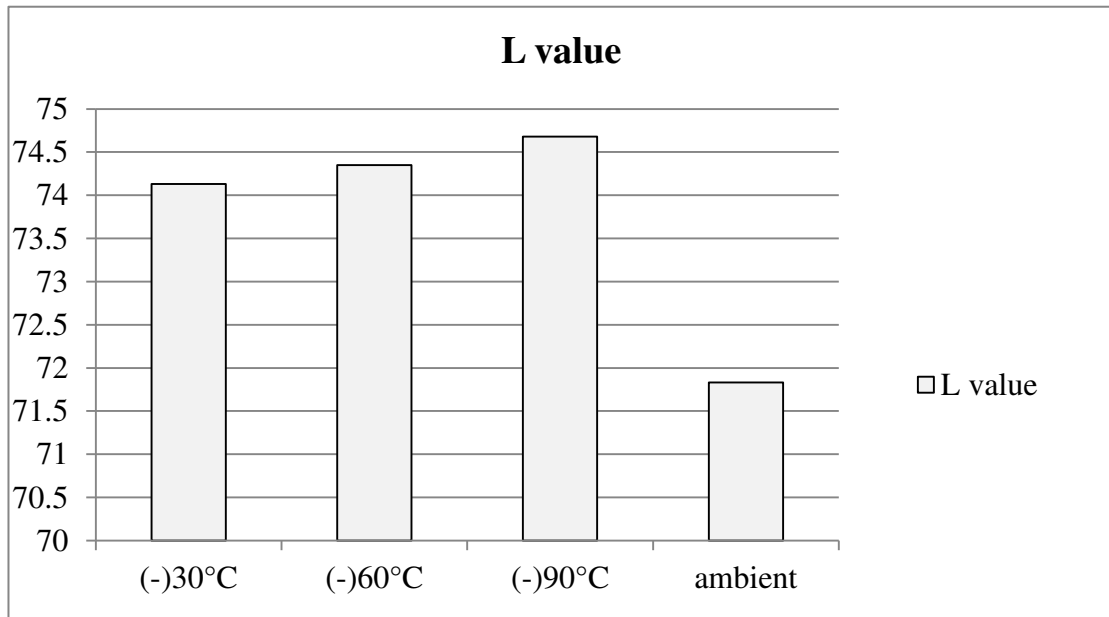
2. Vitamin-C(Ascorbic acid) content:- Garlic is a good source of Vitamin-C(Ascorbic acid). The raw garlic contains about two-third of our daily Vitamin-C needs in 100g of garlic. The Ascorbic acid content of cryo-ground garlic powder at temperatures -30°C, -60°C and -90°C was found to be 25.61, 26.32 and 26.74 mg/100g of dry matter. The Ascorbic acid content in ambient ground garlic powder was 20.11 mg/100 g of dry matter. The retention of Ascorbic acid in cryogenic grinding was observed to be 76.71% and the loss (during drying and grinding) was 23.3%. In the previous studies, the Ascorbic acid content was 27.33±07 mg/100g of dry matter and the retention was 87.62% for freeze dried and cryogenic ground garlic powder compared to fresh garlic sample (Paliwal, 2014). This shows that in the present study, the Ascorbic acid content of cryo-ground garlic powder is in accordance with the data reported in the previous studies.

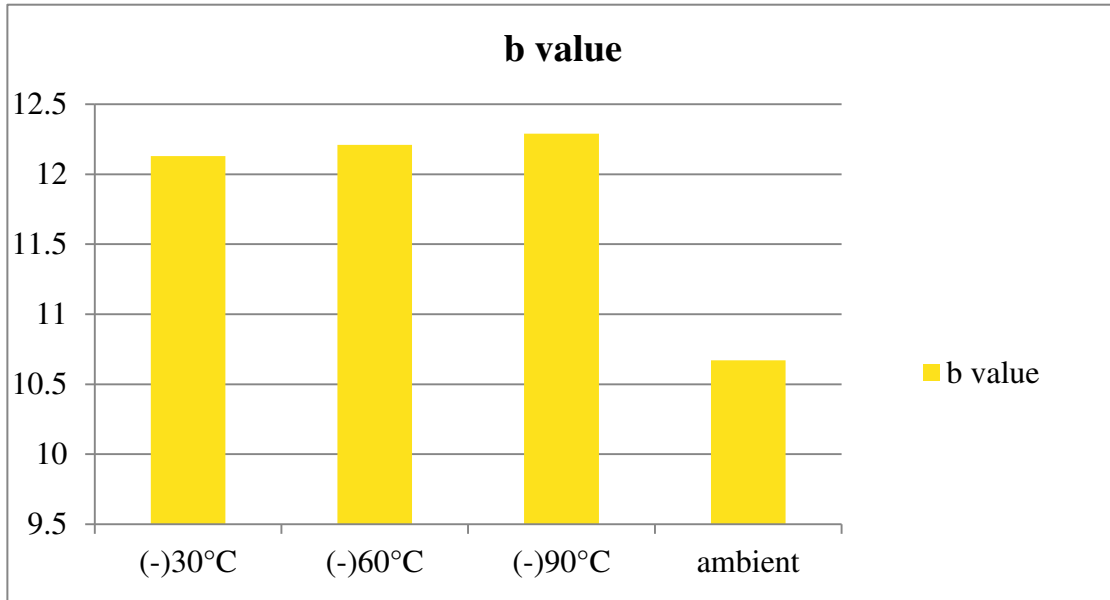


3. Color:- Color plays an important role in indicating quality of product. Colour values (L, a, b) of garlic powder was obtained. It was observed that the value of L at temperatures -30°C, -60°C and -90°C was found 74.13, 74.35 and 74.68

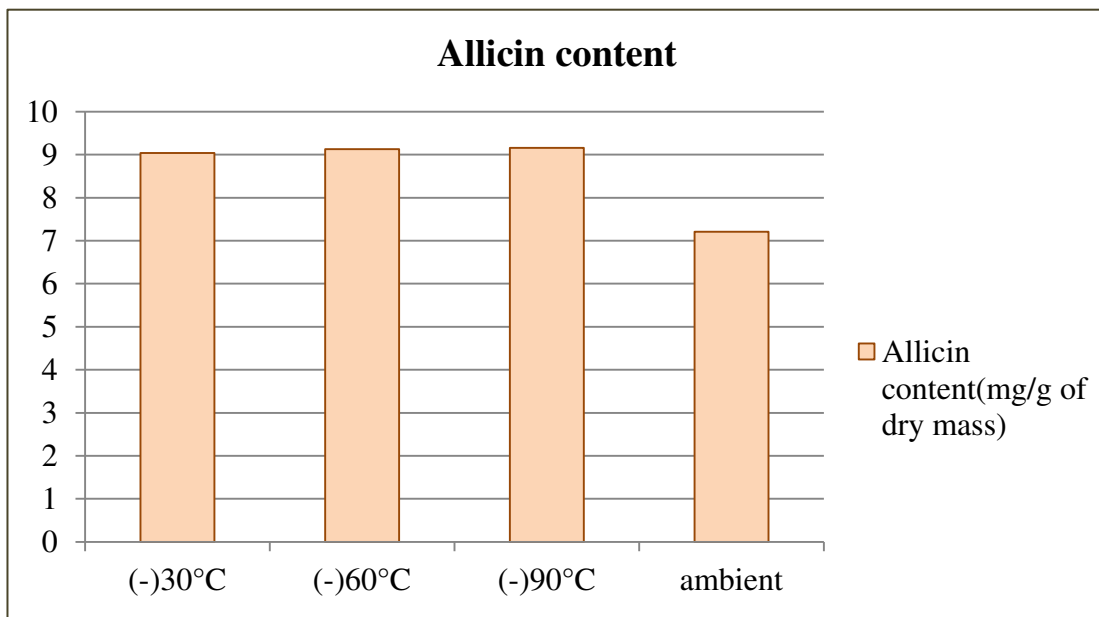


respectively; value of a at temperatures -30°C, 60°C and -90°C was found 5.12, 5.20 and 5.23 respectively; value of b at temperatures -30°C, -60°C and -90°C was found 12.13, 12.21 and 12.29 respectively. The L, a and b values of ambient ground powder was found to be 71.83, 6.43 and 10.67 respectively.





5. Allicin content:- It is important quality parameter to decide commercial value and medicinal value of garlic in local and export market. The allicin content of cryo-ground garlic powder at temperatures -30°C, -60°C and -90°C was found to be 9.04, 9.13 and 9.16 mg/g of dry mass respectively. It was observed that there was a minor change in allicin content with change in cryogenic grinding temperatures. This indicates that there was very little increase in allicin content with the decrease in cryogenic temperature. On the other hand, the allicin content of ambient ground garlic powder was found to be  $7.21 \pm 0.02$  mg/g of dry mass. It was observed that allicin content of cryo-ground garlic powder was significantly higher than ambient ground garlic.





#### IV. CONCLUSION

Garlic powder has particle size that ranged in size from 0.1997mm to 0.2241mm. The larger the particle size, the higher the grinding temperature. Similar to this, the average particle size was likewise small while grinding at a low temperature.

The angle of repose is highest under ambient conditions and lowest at -90°C. Angle of repose readings were in the range of 33.43° to 39.56°. This range of flowability places a powder in the 'Good' and 'Fair' category.

The results showed that the lowest and highest L values were, respectively, 71.83 at ambient grinding and 74.68 at -90°C. The highest and lowest a values were discovered to be 6.43 and 5.12 respectively. a value was found maximum at ambient ground and a minimum value at -30°C. The b number represents how yellow the powder is. The higher b value for a grinding temperature of -90°C was discovered to be 12.29. 10.67 was the lowest number recorded during ambient grinding.

The levels of allicin discovered ranged from 9.16 mg/g of dry mass to 7.21 mg/g of dry mass, respectively. The highest quantity of allicin content was produced by grinding at -90°C, whereas the lowest amount was produced by grinding at normal temperature.

The garlic powder produced by ambient grinding and cryogenic grinding had vitamin-C content in the range of 20.11 and 26.61±13 mg/100g of dry matter, respectively. The temperature of the grinding has a greater effect on the vitamin-C content. It was discovered that the vitamin-C content of cryo-ground garlic powder was higher than ambient ground powder.

Garlic powder had a water activity of 0.369 and 0.351. The water activity was reduced at higher grinding temperature. The water activity was also increased when the grinding temperature was low.

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