

Effect of micronization on the structure and particle size of guar gum

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Abstract. Micronized guar gum was made with a micronization time of 15, 30, 45, 60 min, and its structure and particle size were analyzed. The result of Fourier transform infrared spectroscopy (FT-IR) showed that guar gum had a broader and stronger band between 3100-3700 cm⁻¹, which showed more hydroxyl groups of guar gum were exposed after treated, indicating that the structure of guar gum was destroyed. Moreover, with the increase of micronization time, the particle size of guar gum gradually became bigger which was attributed to the agglomeration of guar gum in the process of micronization.

1. Introduction

Guar gum, also known as tannin extract, is one of the most widely used and cheap hydrophilic colloids in China and abroad (Prajapat A L & Gogate P R, 2015). Guar gum has become one of the largest thickeners in China's food industry due to its low price and good quality characteristics, since it was entered into the Chinese market in 1993. Guar gum is derived from *Cyamopsis tetragonolobus*, an annual herbaceous drought-resistant crop widely cultivated in arid and semi-arid regions of South Asia (Gong H et al., 2012). Guar gum can interact with water in large quantities, so it has a wide range of applications in the food industry (Mudgil D et al., 2018). It is composed of linear backbone of β -1,4-linked mannose units with α -1,6-linked galactose units randomly attached as side chains. The ratio of galactose to mannose is 1:1.6-1:2 (Sumit G et al., 2009). Figure 1 shows the molecular structure of guar gum. Guar gum consists of linear straight chains and some branches. Due to this structure, guar gum has strong water absorption characteristics, good solubility in cold water and hot water, stable viscosity and wide adaptability. And it can be widely used in food, petroleum, daily chemical, paper making, textile, medicine, ceramics and other industries (Szopinski D & Luinstra GA, 2016). At room temperature, guar is not fully hydrated, and the clarity of the solution is poor, which limits its use in the food industry (Hong C H et al., 2010). Chemical modification can improve the dispersion state, viscosity, solution transparency of guar gum. However, the extensive use of chemical reagents can cause environmental pollution, and chemical agents pose a threat to the safety of food. Micronization (mechanical force or fluid power) is used to overcome the force between the guar gum, and destroy the molecular structure. Hence, the guar gum have unique physical and chemical properties such as good solubility, decomposability and chemical activity (Ren GY et al., 2010).



Therefore, the aim of this study was to investigate the effect of micronization on the structure and particle size of guar gum with a micronization time of 15, 30, 45, 60 min. Therefore we can explore the potential possibility of micronization for guar gum modification, and expand its applications in guar gum processing industry.

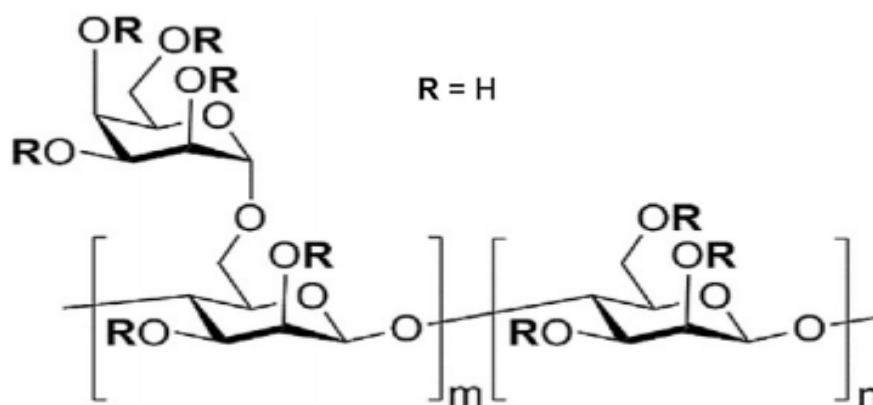


Figure 1. Molecular structure of guar gum(Szopinski D & Luinstra G A, 2016)

2. Materials and Methods

2.1. Materials

Guar gum (food grade) Shandong Yousuo Chemical Technology Corporation

2.2. Fourier transform infrared spectroscopy

Guar gum was characterized by Fourier transform infrared (FTIR) spectrophotometer (American Nicolet Corp. Model 170-SX). The samples were blended with solid KBr powder and about 40 mg of the blend was made into a pellet. The KBr pellet was dried and subjected to FTIR spectrophotometry. Transmittances were recorded at wave numbers between 4000 and 400 cm^{-1} .

2.3. Particle size distribution

A certain amount of modified guar gum sample (dry basis) was weighed, dispersed with absolute ethanol before the measurement. The dispersion was analysed by a Mastersizer 2000 type particle size distribution analyzer (Mavern Instruments, UK).

3. Results and analysis

3.1. Fourier infrared spectroscopy (FT-IR)

FTIR spectra analysis of micronized guar gum is summarized in Figure 2. M0, M15, M30, M45, and M60 represent the micronization time of 0, 15, 30, 45, and 60 minutes, respectively. It can be seen that the guar gum did not show a new absorption peak after the micronization treatment, indicating that the guar gum did not produce a new functional group, which denoted micronization is a physical modification process. The absorption peak of guar gum in the range of 3100-3700 cm^{-1} represents O-H stretching vibration of polymer and water involved in hydrogen bonding. The region of FTIR spectra between 2800 and 3000 cm^{-1} shows C-H stretching modes (Thombare N et al, 2016). The region around 1400 cm^{-1} due to CH_2 deformation was also observed. The range of 1000–1050 cm^{-1} can be ascribed to the presence of pyranose rings in their monosaccharide molecules. Infrared absorption spectroscopy in the band of 800-1200 cm^{-1} reflects the stretching vibration of C-H, C-O and C-OH in guar gum, polymer conformation and hydration process (Mudgil D, Barak S, & Khatkar BS, 2012). It can be seen

from the figure that the absorption peak intensity in the range of 800-1200 cm⁻¹ gradually increases with the increase of micronization time, indicating that the molecular conformation of guar gum changed in the process of micronization.

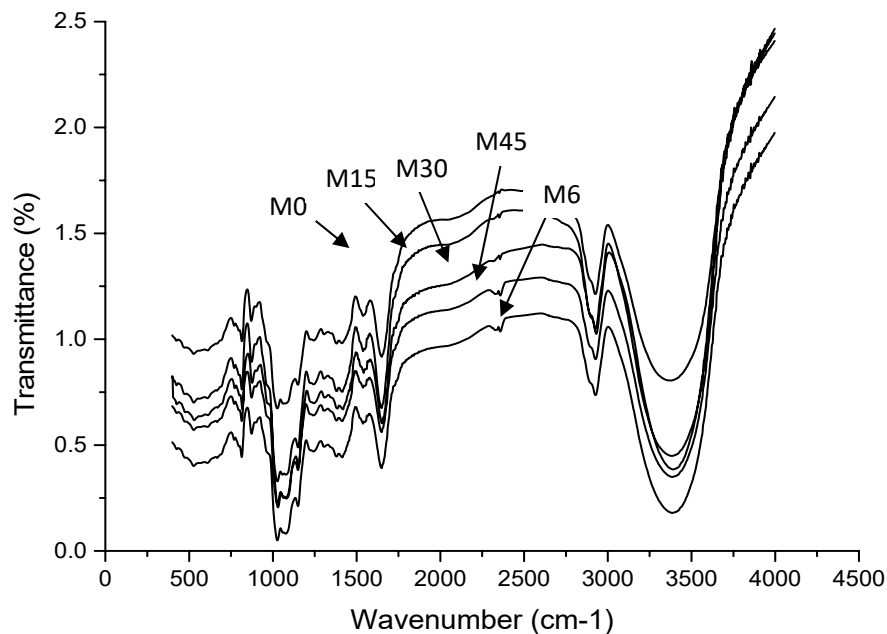


Figure 2. FT-IR patterns of guar gum

3.2. Particle size analysis

The particle size distribution of micronized guar gum with different times is showing in figure 3. As can be seen from the figure, with the increase of micronization time, the particle size of the guar gum gradually increases. The natural guar gum's particle size is about 3 μm , and after 60 minutes of micronization, the particle size reaches 15 μm . The reason may be that the surface of the granules has higher activity after micronization treatment, and agglomeration occurs. And then its particle size increases. Another possible reason is that guar gum cannot disperse good during the micronization process and agglomerate together (Rohart A & Michon C, 2016).

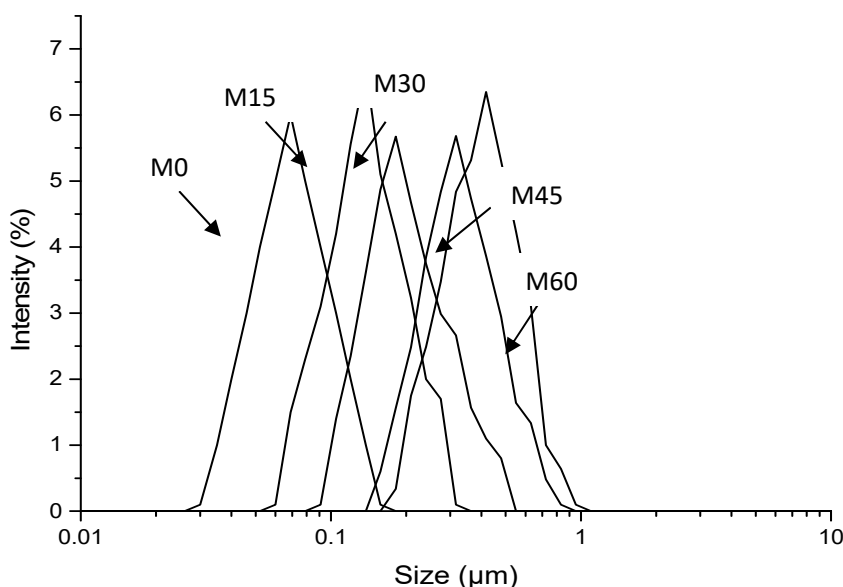


Figure 3. Effect of Micronization on particle size

4. Conclusion

After micronization, the molecular structure of guar gum was destroyed, more hydroxyl groups were exposed, and hydration enhanced. Under the influence of the transient thermal effect, guar gum agglomerated and the molecular size increased. The analysis results show that the micronization can change the properties of guar gum to a certain extent, which provides a theoretical basis for the application of guar gum in the food industry.

Acknowledgements

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