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Bee Makes the Pollen Wall Breakable for Human Digestion

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Abstract

Introduction*:** Cellulose consists of β-(1 → 4)-linked glucose units arranged in a ribbon-type conformation in a zigzag pattern. Parallel chains fit closely to each other and associate with multiple hydrogen bonds to give rise to long fibers, which are totally insoluble in water and relatively inert. Although subject to some swelling in water, cellulose is entirely unaffected by boiling in water. ***Objectives: The objective of this study is to investigate the potential for breaking down the pollen wall of honey-collected pollen using acid with pH of stomach acid, and to determine whether the honey-making process by bees is necessary for human consumption of the amino acid content present in pollen. ***Materials and Methods*:** Natural litchi flower honey was collected from Litchi Garden of Doctor Honey, Health & Harvest Dinajpur, Bangladesh in March 2021. 1 ml natural raw honey of litchi flower was diluted with 5 ml distilled water in a conical test tube. (Falcon). This was centrifuged in a swing-out rotor centrifuge (Labofuge, Germany) at a speed of 900 rpm for 10 minutes. The pollens made a pellet at the bottom of the tube. A sample from the pellet was taken on a glass slide and checked under the light microscope (optima) to ensure the presence of pollen. Citric acid was also added to the pollen. ***Results*:** Many of the pollen's walls were found broken within one hour. It is visible that the contents of the pollen sacs are oozing out. One or two broken pollen was found in each 100 of the sample before adding acid whereas many were broken after adding acid. ***Conclusion*:** Honey-collected pollen's wall can be broken down using stomach acid, emphasizing the importance of the honey-making process for accessing amino acids, while preserving pollen in honey is crucial for maximizing nutritional benefits.

Keywords: Cellulose, Amino acids, Crystallization, Centrifugation, Chemical and mechanical manipulation.

INTRODUCTION

Cellulose consists of β-(1 → 4)-linked glucose units arranged in a ribbon-type conformation in a zigzag pattern. Parallel chains fit closely to each other and associate with multiple hydrogen bonds to give rise to long fibers, which are totally insoluble in water and relatively inert. Although subject to some swelling in water, cellulose is completely unaffected by boiling in water. Breaking the pollen wall requires many steps of different chemical and mechanical processes. Pollen walls are made of two layers, sporopollenin outside (exine) and intine. sporopollenin is so tough that it is called the "diamond of the plant world". The inner wall is made of cellulose. Whether the human digestive system can break down pollen walls is still controversial and most data says humans cannot. Pollen contains substantial amounts of amino acids which could be a very good source of nutrition for humans as amino acids are the building blocks of proteins that take part in many functions of the human body including immunity and the enzyme system. Ruminants have the capacity to digest cellulose of pollen wall but the end product is not edible for humans due to lack of availability. Breaking natural pollen walls artificially needs different types of chemical and mechanical manipulation. Our study is probably the first time study to show that pollen collected from honey can be broken by simple stomach acid. It proves that for human consumption of amino acids in pollen, pollen should come through the honey-making process of bees. Hence consumption of pollen directly from nature is not useful for humans in the context of pollen sac content. Most of the honey in the USA market is free of this pollen due to filtration by the company. These pollens are

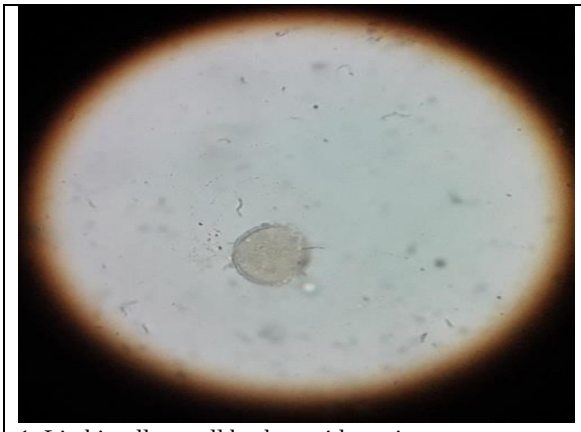
filtered to avoid possible crystallization which decreases the market value of the company's honey. To ensure the nutritional value, the pollen should not be filtered out.

OBJECTIVES

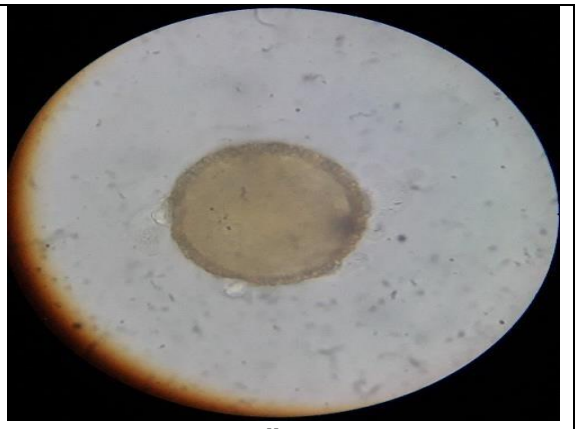
The objective of this study is to investigate the potential for breaking down the pollen wall of honey-collected pollen using simple stomach acid and to determine whether the honey-making process by bees is necessary for human consumption of the amino acid content present in pollen.

MATERIALS AND METHODS

Natural litchi flower honey was collected from Litchi garden in Dinajpur, Bangladesh in March 2021. 1 ml natural raw honey of litchi flower was diluted with 5 ml distilled water in a conical test tube. (Falcon). This was centrifuged in a swing-out rotor centrifuge (Labofuge, Germany) at a speed of 900 rpm for 10 minutes. The pollens made a pellet at the bottom of the tube. A sample from the pellet was taken on a glass slide and checked under the light microscope (optima) to ensure the presence of pollen. The pellet was taken on a glass slide and citric acid with a pH of 2 (similar to stomach acid, HCL) was added to the pellet drop by drop for 3 minutes. The pH of citric acid was checked by pH strip (m quant, Germany) then the pellet was checked after 15 minutes, 30 minutes, and one hour under the light microscope.



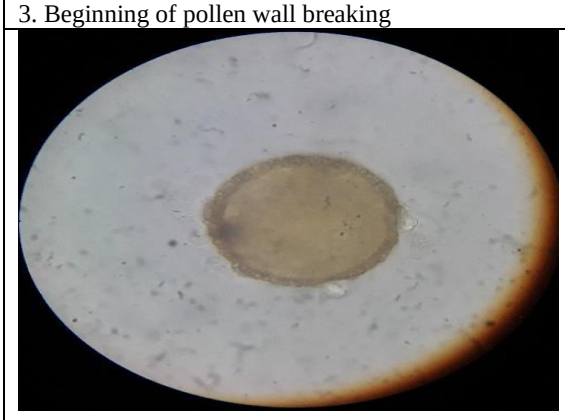
1. Litchi pollen wall broken with oozing content.



2. Intact rose pollen

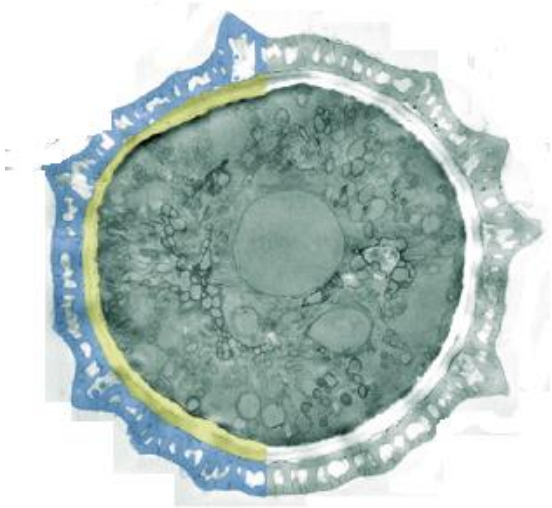
3. Beginning of pollen wall breaking

4. Litchi pollen wall breaking with oozing content.

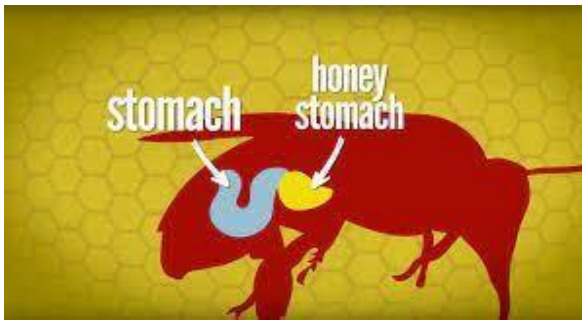


5. Rose pollen intact even after acid addition (These pollens were collected directly from flowers)

6. Litchi pollen wall breaking with oozing content.



7. Structure pollen wall



Pic: Double Stomach of Bee.

RESULT

Many of the pollen's walls were found broken within one hour. It is visible that the contents of the pollen sacs are oozing out. One or two broken pollen was found in each 100 of the sample before adding acid whereas many were broken after adding acid.

DISCUSSION

Pollen contains 22.7% of protein including 10.4% of essential amino acid [1]. More than 5% of the pollen sac content is lipid comprising of essential fatty acids phospholipids and phytosterol [2]. Vitamins include A, D, E, B1, B2, B6, and C and acids include pantothenic, nicotinic, and folic. Phenolic compounds such as flavonoids, and leukotrienes comprise more than 1%. Flavonoids include kaempferol, quercetin and isorhamnetin. These flavonoids help us to fight against cancer, inflammation, and other diseases. Micronutrients include selenium, zinc, manganese, and magnesium [3]. Sporopollenin, the outer wall of pollen is highly resistant to acid and alkali. This can preserve the pollen even as a fossil. It is a highly cross-linked polymer composed of carbon, hydrogen, and oxygen and has been found chemically intact in sedimentary rocks some 500 million years old [4]. Following pollination, the intine i.e. the inner wall secretes an enzyme cocktail (acid phosphatase, ribonuclease, esterase, and amylase) to break up the exine. (Pollen and stigma structure and function: the role diversity in pollination [5]. Cellulose has beta bonds which need beta glucoside enzyme to be broken and this is absent in the human digestive tract [6]. Humans can digest starch and glycogen that have alpha bonds. It is not clear how much human stomach acid can work on cellulose. In one study more than 70% of the pollen was found intact in human feces after ingestion of pollen [7]. An 80% increase in pollen-derived nutrient availability was found when the pollens were ingested after breaking the walls [8]. Ruminants have got much bigger digestive tracts allowing a longer stay and cellulase enzyme-secreting organism ruminococcus. Several attempts have been made to break the pollen wall artificially to make the pollen content available for human use. Use of Steam explosion [9] use of HCL, ultrasonic method, enzyme method, and finally supercritical CO2 rapid depressurization yielded different results. Scanning electron microscope showed pollen breaking wall was effective at the range of pressure 13.2-46.8 MPa, temperature 33.2-66.8C, and co2 flow rate 6.6-23.4L/h [10]. Interestingly, these were done on the pollen collected from the pollen store of beehives which were not yet processed inside the bee stomach. Bee has got two chamber stomachs with a valve that prevents backflow from the hind stomach. Once inside the front stomach or pollen sac, the pollen walls are attached by Bifidobacterium asteroided and coryneform. These bacteria have got enzyme cellulase which can break the cellulose of the pollen wall. There are many types of bifidobacterium some inhabit the

human gut excluding the two mentioned already which can break carbohydrates other than cellulose [11]. Most of these pollens with semi-broken wall is regurgitated into the honey and some are taken to the hind stomach for consumption by the bee itself. The pollen sac wall of the bee lacks any absorption capacity. Ruminococcus are found in herbivorous animals where they help the animal to digest grass that contains cellulose. Some ruminococcus are found in the human gut but their role is not clear yet in the capacity of cellulose degradation. Rather some cases are found where they create diseases like Crohn's disease [12]. More than 75% of the store honey on the USA market was filtered and free of pollen. Even many honeys with "Raw "labels were found without any pollen which was supposed to have pollen. (Filtering honey almost every filter removes some pollen. Vaughn Bryant. Bee culture. Sep 8, 2017.) In a more than billion-dollar world market of honey at present, it deserves the attention of health authorities how much of our otherwise available nutrition is taken away by filtration from honey.

CONCLUSION

This study demonstrates that the pollen walls of honey-derived pollen can be effectively broken down using stomach acid, highlighting the importance of the honey-making process for human consumption of amino acids present in pollen. Direct human consumption of amino acid pollen from nature is limited due to the tough sporopollenin and cellulose composition of the pollen wall. Filtering pollen from honey, as practiced in the USA market, reduces the nutritional value of the honey. Preserving unfiltered, pollen-rich honey is crucial for accessing the potential nutritional benefits of pollen. This research emphasizes the significance of the honey-making process and unfiltered honey consumption for optimal pollen sac content utilization.

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