

Holy Cow! Between Meat and Milk; a Scientific Explanation for Waiting

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Jewish law prohibits cooking and eating meat and milk together. This is derived from the pasuk "לֹא תִבְשֵׁל גְדִי בְחֵלֶב אִמּוֹ" which translates to "you should not cook a kid in its mother's milk"[1]. This law is expounded upon in the Talmud, where it is made clear that there is also a prohibition of eating meat and milk together. This stringency from the Talmud acts as a safeguard for the *issur* of cooking meat and milk together. *Halacha* further rules that one must wait a certain number of hours between eating meat and milk. Commentators offer explanations to this ruling and they can be categorized into three main reasons.

The first reason, associated with the Rambam, stems from the concern that meat may get stuck between the teeth and remain there even after a person is done eating. If he later drinks milk, he would essentially be eating meat and milk together [2]. Here the focus is on having meat and milk present in the oral cavity simultaneously. According to this opinion, it wouldn't matter how much of each food is in the mouth, or if both the meat and the milk can actually be tasted.

The second reason concerns taste. According to Rashi, eating milk and meat within a short time frame is prohibited in order to avoid having both tastes in one's mouth at the same time. Meat, which is fatty, can often leave an aftertaste in one's mouth, and if so, one cannot have milk products until this taste passes.

The third reason, brought down in *Kreisi Upleisi* 89:3, written by Reb Yonoson Aibshitz, refers to digestion. He argues that it wouldn't matter if both meat and milk tastes were present in the mouth, or if there was food stuck between the teeth. His is of the opinion the focus is that meat and milk should not be in contact with each other

until after digestion, long after either taste or stuck food would remain.

There are different customs as to how long one should wait between meat and milk. Even though the Gemara does not mention how long one should wait, specific times are brought down by later sources. The primary, and most well-known custom, is to wait six hours as suggested by Rabbi Yosef Karo. The Rema suggests waiting one hour. Some suggest three hours, and other opinions are to wait five or five and a half hours. Is there a scientific explanation for these times? How were these specific times decided upon and do the differences have to do with the different reasons for the prohibition?

Digestion of food involves two aspects: mechanical and chemical digestion [3]. In the oral cavity, the main digestion is mechanical which is done by our teeth. Our front teeth, known as incisors, bite and cut the food, and our back teeth, the molars, chew and grind the food in a process called mastication. The second part of digestion in the mouth is chemical digestion which consists of two main enzymes named salivary amylase and salivary lipase (or lingual lipase), secreted into the mouth in saliva. Each enzyme's activity is focused on a different type of food. Salivary amylase digests starch into maltose and maltotriose and works at an optimum pH of 6.7 to 7.0. Lingual lipase hydrolyzes the ester bonds in triglycerides to form diacylglycerols and monoacylglycerols. Meat is completely starch-free so the enzyme responsible for meat digestion is lingual lipase which digests the fat in the meat.

Once the food is small enough and mixed with enzymes, it is termed bolus and passes into the esophagus which will deliver it to the next part of the digestive tract. Lingual

lipase is also present in the stomach, where the pH is much lower. The low pH condition of the stomach is optimal for the enzyme's activity, making the stomach a more effective location for its work. Here, the lingual lipase hydrolyzes triglycerides to free fatty acids and partial glycerides. The stomach can convert close to 30% of fats into diglycerides and fatty acids by about two to four hours after eating [4].

Gastric emptying is the amount of time that it takes for the food to be emptied out of the stomach. Small bowel transit is the amount of time that it takes for the food to move from the oral cavity to the ileum, then to the cecum, after which the food is excreted from the body. Following a study conducted where a wireless motility capsule was inserted through the oral cavity, it was determined that the normal range for transit time was two to five hours for gastric emptying and two to six hours for small bowel transit [5]. Because the reason for waiting between meat and milk is for the food to be digested, the reason behind three and six hours is better understood. The wait time of three hours is based on the assumption that digestion is completed once the food leaves the stomach. Additionally, the wait time of six hours is based on the assumption that the food has to fully leave the body to be considered fully digested.

When understanding the concept of the taste remaining in the mouth, one must analyze where the flavor is coming from. Does the flavor come from parts of the food that are still in the mouth, or does it come from food that was already swallowed? Sometimes when eating a lot of food, the stomach distends and presses on the diaphragm [6]. This can cause a hiccup sensation and along with the hiccups comes an aftertaste. But this is not the main reason for aftertastes. Cordelia Running, director of the Saliva, Perception, Ingestion and Tongues (SPIT)

lab at Purdue University, says that aftertastes are generally caused by "little bits of the actual flavor stimuli that might hang around." Physical remnants of food can get caught in the mouth and molecules can remain in the saliva or mucus causing this aftertaste [7]. The gustatory cells, responsible for taste in our mouth, can pick up food stuck between the teeth, remnants of food on the gums, or the smallest molecules which can result in an aftertaste. However, the food or residual taste are considered having been digested sufficiently from a *halachic* perspective.

Meat contains two main parts which need to be digested: fat and protein. While both are mainly digested in the stomach, unlike protein, fat can be partially digested by lingual lipase in the mouth. This is substantial because fat is the major contributor to the flavor development in meat [8]. There is variation among animal species in flavor development resulting from their specific fatty components. Hard aged cheeses also have many fatty residues, which is the reason why we wait to eat meat after consuming these types of cheeses [9]. This means that it doesn't matter that protein can't be digested in the mouth because once the fat is digested the flavor will be gone. Due to the pH of the mouth not being ideal for lingual lipase, it may take longer for the fat to be digested and the aftertaste to disappear. Nevertheless, after a few hours the fat will be digested either by lingual lipase or the food particle being swallowed.

The different opinions on waiting times regarding eating meat and milk would support different reasons. When one chews meat but does not swallow it, he must still wait before eating milk. This would support the first reason suggesting that we wait because of food being present together in the mouth [10]. When one swallows meat without chewing, he is still obligated to wait

which would support the reason regarding digestion. When one swooshes meaty soup in his mouth and then spits it out without swallowing anything there is no requirement to wait. This would support the reason for meat being stuck between our teeth. With soup nothing gets stuck and therefore it is permitted to eat milk immediately after as long as he cleans his mouth out so that there is no aftertaste. This supports the second reason.

These scientific explanations offer insight into Chazal's reasoning behind waiting times. Although there isn't always consistency with the science, the *halacha* of waiting between milk and meat should be followed to the full extent of time as decided per rabbinic guidance or family tradition.

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