

## One beer please

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**B**eer has been around for thousands of years. Beer foam has not. And beer foam, like beer haze, is one of today's hot topics in the world of beer brewing. What a beer should look like – once served in a glass – has become paramount for a brand's commercialisation, which is one of the reasons why there is much hustle around the chemistry at work in such a process. It has been known for a while now that a number of proteins are involved in foam formation but it wasn't possible to pinpoint which protein was more involved than another. Finally, it appears that one barley protein has managed to wriggle out of the crowd: Lipid Transfer Protein 1 or LTP1.

The first traces of beer stretch back 6'000 years to the time of the Sumerians. It is thought that the process of fermentation was discovered quite by chance – probably when a chunk of bread, or some grain, was left to dampen and, in doing so, fermented and produced an inebriating pulp. In fact, baked bread may well have become the way an essential ingredient of beer was stored and transported.



Drinking Beer, Andriy Khomyk

Courtesy of the artist

When the Sumerian empire collapsed, the Babylonians moved in and continued the tradition of beer brewing. And they are known to have brewed over twenty different types of beer. It was the woman's job to brew, as it was to make bread in those days. The Sumerian priestesses were the first to brew beer, and this may be where the connection between religion and beer stems – although it was of popular acceptance that the intoxicating side effects of beer could only be of

divine origin. Beer possessed a spirit since it could possess that of the consumer.

Beer tradition spread to the west – as so many traditions did. When the Romans came along, they brought with them the culture of wine and beer was nudged into the more 'barbaric' spheres. As a souvenir of their passage though, they gave beer the name it has today, as 'beer' comes from the Latin 'bibere' meaning 'to drink'.

In Germany however, beer became hugely popular and remained so. As it has in many Nordic countries. In the middle ages, numerous monasteries brewed their own beer devising methods and tastes, which gradually became more and more sophisticated. Monks could well have taken to beer brewing because it gave them something substantial to put into their stomachs during periods of fast. It has been reported that, in some monasteries, monks had the permission to drain up to 5 litres of beer per day to quench their...hunger.

It is not clear what the aspect of beer could have been in those days, but historians do agree that foam was not part of the beverage's aesthetics and that there was probably very little, if none at all. When barley is put through the brewing process, many of its proteins end up in the final product, though very few are still in their native state: the great majority are split into smaller polypeptides. LTP1, however, is one protein that survives the brewing; though denatured, its sequence is still intact. And it is thought that it is the denaturation of LTP1 that is one of the secrets of beer foam.

In vivo, LTP1 is a small globular protein, with a central and conical hydrophobic core, which stretches from one end of the molecule to the other. A C-terminal stretch of amino acids of undetermined structure acts as a lid. In the process of beer brewing, LTP1 loses its 3D structure but it hates the water it is forced to rub shoulders with. So it grabs hold of a bubble of CO<sub>2</sub> – a side product of barley fermentation – and then rises to the surface of the liquid. In effect, LTP1 proteins form a coat around every beer bubble. And what is a bubble's enemy? Grease. And LTP1 loves it. A dirty glass, lipstick, or crisps are a beer foam's worst enemy. When LTP1 encounters grease, it is dissolved immediately. So the bubble bursts...and the foam disappears.

The primordial role of LTP1 in barley is not for the pleasure of bar tenders and the maintenance of beer foam. But besides this pleasing coincidence for the consumer's eye, no one really knows what LTP1's function in vivo is. In vitro, it can comfortably lodge lipids and various fatty acids in its central core. So it was thought that LTP1 was probably involved in lipid transport across membranes and perhaps even membrane biogenesis. The structure of the protein seems to be expandable and could take on various functions depending on its ligand. What is more, LTP1s are located in the cell wall and it has been suggested that LTP1 could have a role in cutin monomer transport; there is indeed a large concentration of LTP1 in the surface wax. However, it is now known that LTP1 is secreted, which leads to other hypotheses.

The discovery that barley LTP1 undergoes a lipid posttranslational modification in vivo offered yet another intriguing hypothesis. Barley LTP1s have been reported to play a role in plant defence. The lipid which is bound to LTP1 could have antimicrobial activity toward fungi and bacteria, perhaps by interfering with the pathogen's membrane.

LTP1 function *per se* remains unresolved. But research around its role in maintaining beer foam – as that of many other proteins which float in a glass of beer – is thriving. If the quantity of LTP1 were increased, would there be more foam? Possibly. And much has been done in this respect – especially when you know that the presence of LTP1 in barley depends on the weather: the wetter the summer, the less LTP1 in barley...

One of the more 'natural' ways to introduce larger quantities of LTP1 in beer would be to harvest barley that produces large amounts of the protein. A less natural procedure would be to introduce the LTP1 gene into a yeast genome – which has already been performed by a German team. Though brewers have shown some interest, it will not be a smooth affair to make beer consumer's swallow genetically modified beer... So, if you like a beer with a consistent head, the most harmless and easiest way to go about it is to make sure that your glass is squeaky clean and your lips grease free!

## Cross-references to Swiss-Prot

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