**Foaming/Frothing of milk**

One property of milk that is becoming more apparent to the general public is its frothing or foaming capacity, for use in coffee. Last year, within a week I had two conversations related to milk frothing gadgets. In the first, the milk would not produce a froth and it was concluded that the machine was faulty. However, with perseverance the same machine did produce an acceptable foam with other purchased milk products. In the second, the user observed that every purchased milk frothed differently, both in terms of its volume and its stability. Both had correctly concluded that milk could vary considerably in its foaming ability. A further observation was that “filtered” milk was more consistent in its frothing behaviour, but there is no simple explanation why this should be the case.

I have long had a peripheral interest in frothing, but without studying it in detail. I have now started to do this, but from home. This was prompted by my daughter in law who in January purchased a milk frother and asked me why some milk samples frothed better than others? One of the 64,000 dollar questions in dairy science! I needed to investigate this myself and purchased a machine for about £40. My first testing session was with four locally purchased milk samples. The best foam (to my surprise) was from full cream milk. Skim milk produced a reasonable foam but the sample of semi-skim milk hardly produced any foam. BOB milk (high protein, low fat) also foamed well but not quite as well as the full cream milk. I was pleased that the machine showed such large differences in foaming capacity. I also observed differences in the foam stability and also the foam structure. Since then, most of the semi-skim milk samples I have tested have produced much better foams than the first sample.

From background reading, some general principles are that proteins encourage foam formation, whereas fat, lipolysis and free fatty acids tends to suppress foam formation. Huppertz (2010) reviewed the foaming properties of milk. Some of his conclusions were that “skim milk foams could be extremely stable, particularly when they are formed at 40 to 50 C. The presence of lipid can be detrimental to the formation and stability of milk foams. The presence of phospholipids, free fatty acids and partial glycerides strongly impairs foaming of milk”

Chen et al (2014) measured the composition of 25 bulk milk samples, collected over a twelve month period. A standard foaming test was performed on these samples and the time required to produce a stable foam ranged from 24s to 205s. There were variations in all other measured properties; the range of values is recorded for some of these below:

pH 6.73 to 6.87

Protein (%) 2.89 to 3.56

Fat (%) 3.62 to 4.77

Ethanol stability: 84 to 100%

Rennet coagulation time 12 to 24 min

Foaming showed the widest variations.

In this study, it was not possible to find a simple correlation between foaming capacity and any of the measured compositional factors. It is still not clear to me what causes variations in foaming capacity in purchased milk products but my current thoughts are that it has to be due to some of the minor and probably surface active components in the milk.

Thus supplying milk to be used in frothing applications is not straightforward. It is also not easy to predict in advance when too much foam may be a problem, for example in some blending and filling operations.

I am now looking at standardising the foaming test and I plan to evaluate more purchased milk samples. Unfortunately I do not have a GC-HPLC-MS machine in my kitchen to measure components of interest such as phospholipids and free fatty acids. I may freeze small samples in case here may be somebody out there with an interest in measuring them.

Huppertz, T. (2010). Foaming properties of milk: A review of the influence of composition and processing. *International Journal of Dairy Technology*, 63 (4), pp. 477-488

Chen et al (2014). Effect of seasonal variation on the composition and properties of raw milk destined for processing in the UK. *Food Chemistry*, 158, pp. 216-223

**Michael Lewis**

**March 2020**