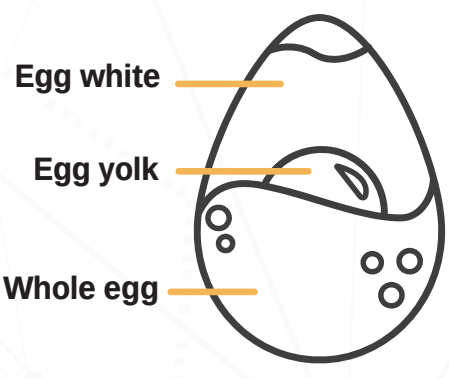
BIOCATALYSTS | A BRAIN Group company

Egg Processing

THE USE OF ENZYMES FOR IMPROVING FOAMING PROPERTIES OF EGG WHITES



Traditionally, egg ingredients were supplied in the form of whole eggs. However, today's food processors can choose from a wide range of egg ingredients where various processes are used to produce whole egg, egg yolks or egg whites, which can be liquid or dried. In the past it was thought that fresh whole eggs and liquid products had the best functionality. However, both liquid and dried egg products can be treated with enzymes to improve functionality.

The main functional property of egg white is its high foaming capacity. However, for optimal foaming capacity, reducing contamination of egg yolk lipids is key. This very often proves challenging for high throughput egg processors. A simple yet effective solution is the use of an enzyme to help break down the lipid and ensure the egg white can maintain its full foaming capacity.

Egg yolk typically contains 32% lipids and phospholipids; these lipids compete with the proteins for space on the air bubble surfaces at the air/liquid phase of the foam. Whipping egg whites enables protein bonds to form a protective layer around the air bubbles. When lipids are present in the egg white foam they begin to weaken the layer around the air bubbles and destroy the egg white foam. Lipase and phospholipase enzymes are efficient in breaking down any contaminating egg yolk lipids and phospholipids when eggs are separated to improve the foaming properties of egg whites.

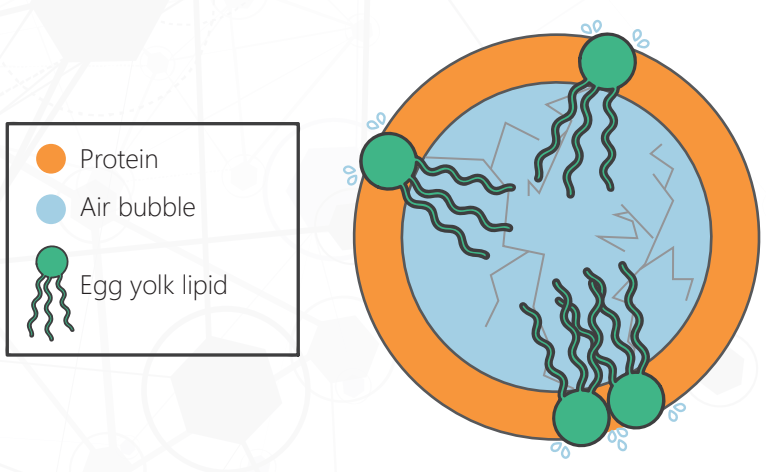


Figure 1 Egg yolk lipids weakening the protein layer

LIPASES

Lipases catalyse the hydrolysis of fats and oils, breaking down triglyceride molecules into free fatty acids and glycerol. The action of lipases on egg yolk hydrolyses the free lipids reducing the detrimental impact of egg yolk presence in egg white foaming performance. Lipases, such as Lipomod® 34MDP, with the ability to broadly hydrolyse all fatty acids on the triglyceride molecule efficiently break down any contaminating lipids to produce a superior egg white product capable of an enhanced foam stability.

Whilst the hydrolysis of contaminating egg yolk lipids can improve the foam stability of egg whites, free fatty acids are precursors for the formation of other flavour compounds. The release of the fatty acids from the glycerol backbone using a lipase can impart off-flavours. A high free fatty acid content in the egg white can lead to the production of an undesirable taste not suitable in certain applications.

PHOSPHOLIPASES

Phospholipase enzymes modify phospholipids, depending on the phospholipase specificity towards targeting certain bonds on the phospholipid molecule. Phospholipase A2 enzymes such as Lipomod® 833L2 and Lipomod® 699L modify phospholipids to lyso-phospholipids by targeting the fatty acid specifically at the sn-2 position on the glycerol backbone.

A Phospholipase A2 releases this specific bond on the phospholipid molecule found in egg yolk and leaves the remaining fatty acids intact. The use of a Phospholipase A2 enhances the functionality of egg whites by modifying the contaminating egg yolk lipids whilst maintaining a lower free fatty acid content and therefore not contributing to an undesirable impact on flavour. Hydrolysis of the fatty acid at the sn-2 on the phospholipid glycerol backbone

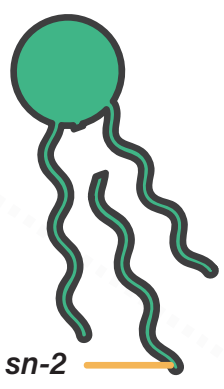


Figure 2. Egg yolk lipid cleaved at position 2

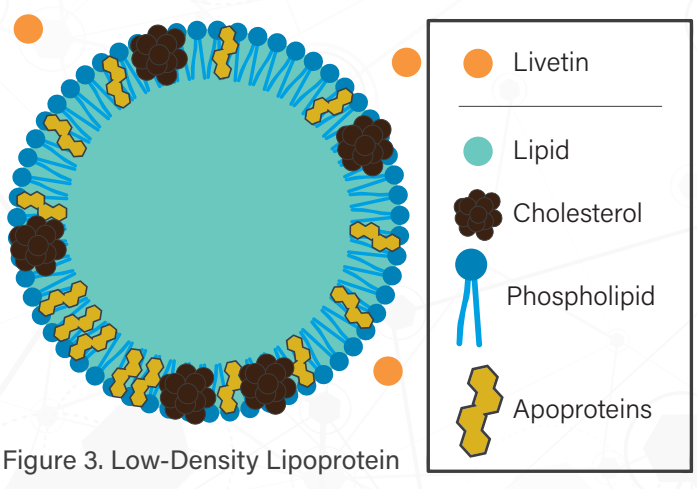


Figure 3. Low-Density Lipoprotein

Egg yolk contains low-density lipoproteins (that consist of cholesterol, phospholipids, apoproteins and lipids) and livetin, a water-soluble protein. It is the lipoproteins in egg yolk that disrupt the oil-water interface and contribute to the emulsifying properties of egg yolk.

The yolk structure is much looser when hydrolysed using a Phospholipase compared to a Lipase. Phospholipase hydrolysis does not totally break down the low-density lipoproteins leading to a greater dispersion of the low-density lipoproteins. A looser yolk structure can be achieved by hydrolysis using a Phospholipase leading to an improved foaming capacity compared to egg yolk contaminants hydrolysed using a lipase.

Egg yolk hydrolysed using a lipase partially degrades the low-density lipoproteins, this hydrolysis can increase the exposed charge of the lipid fractions causing them to aggregate. This aggregation however can contribute to an improved foam stability. The differences in the structural and physiochemical properties of the hydrolysed egg yolk by the lipase and phospholipase contribute to the variations in foaming properties of the contaminated egg whites. These variations in egg white foaming performance are desirable for different food applications and can be achieved by use of different enzymatic activities.

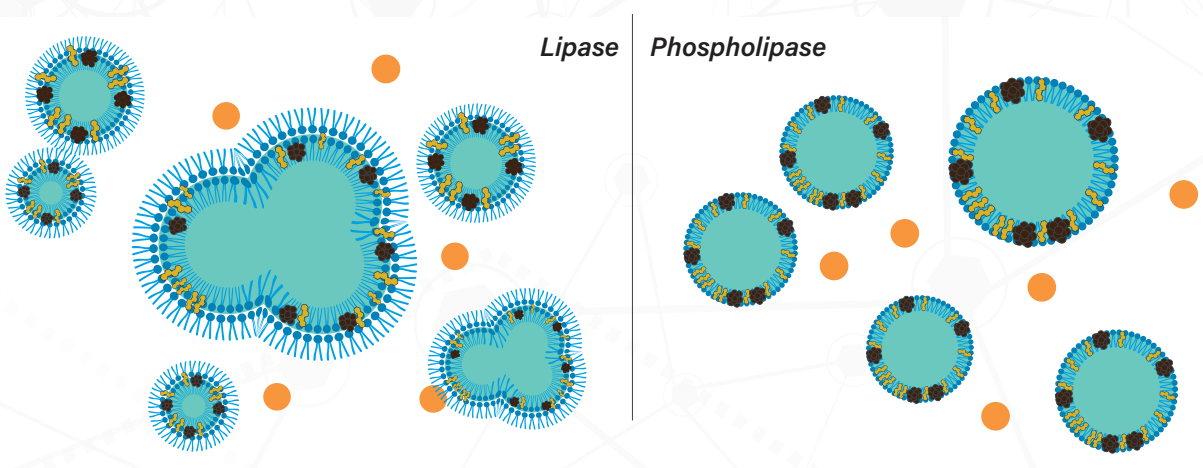


Figure 4. Theoretical foaming properties of egg yolk plasma hydrolysed by Lipase vs Phospholipase

BIOCATALYSTS' RANGE OF ENZYMES FOR IMPROVING FOAMING PROPERTIES

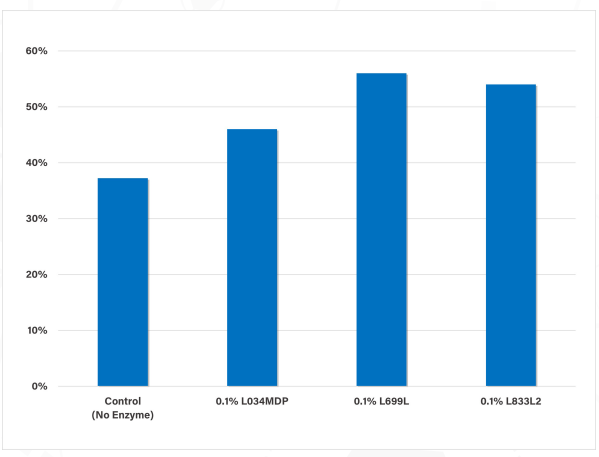


Figure 5. Improved foaming capacity of egg white by removing contaminating yolk lipids using Lipomod® 34MDP, Lipomod® 699L and Lipomod® 833L2 at 0.1% dosage and incubated for 3 hours at 40°C

The foaming capacity of egg whites can be measured as the increase in the interfacial area that is created by whipping the protein.

Figure 5 illustrates the increase in foam volume as a percentage of the initial egg white liquid volume. Broad specificity Lipase (Lipomod® 34MDP) has a positive impact on foam volume in comparison to the control due to the removal of lipid traces. The two Phospholipase A2 enzymes (Lipomod® 699L and Lipomod® 833L2) performed the best in increasing the foaming capacity of egg whites by creating improved foaming properties of the egg white proteins.

Unique blends of Phospholipase A2 and Lipase enzyme activities could be beneficial in different applications to meet unique success criteria.

The significant proportion of protein in egg whites makes it an ideal ingredient for creating a foam. When whisked air is introduced into the mixture and is encapsulated in a thin layer of protein which protects the air bubbles and produces a more stable foam.

Figure 6 shows two controls; the egg white foam with the highest stability with 0% egg yolk contamination and no enzyme treatment, and the effect of 0.25% egg yolk contamination (with no enzyme treatment) on the foam stability, illustrating the need for enzymatic treatment on contaminated egg whites prior to whipping.

The stability of the foam is measured as the amount of drainage between period of 30 seconds and 60 minutes, as a percentage of the initial volume of liquid egg white.

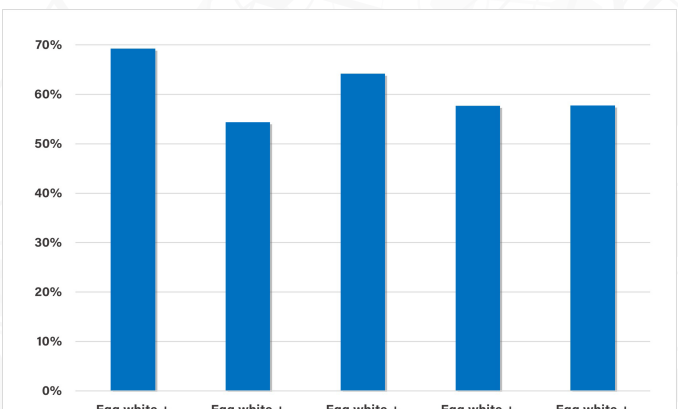


Figure 6. Improved foam stability of egg white by removing contaminating yolk lipids using Lipomod® 34MDP, Lipomod® 699L and Lipomod® 833L2 at 0.1% dosage and incubated for 3 hours at 40°C

Whilst removal of egg yolk lipids using the two Phospholipase A2 enzymes (Lipomod® 699L and Lipomod® 833L2) does increase the foam stability compared with no enzymatic treatment, broad-spectrum lipase, Lipomod® 34MDP, is the most effective in improving the stability of foam when contaminated with egg yolk lipids.

Lipomod® 833L2 (L833L2)

- Microbial Phospholipase A2.
- Hydrolysis of fatty acids at position-2 of the phospholipid.

Lipomod® 699L (L699L)

- Porcine-derived Phospholipase A2.
- Hydrolysis of fatty acids at position-2 of the phospholipid.

Lipomod® 34MDP (L034MDP)

- Microbial lipase.
- High lipase and esterase activity.
- Broadly active against short, medium and long chain fatty acids on all 3 positions on the triglyceride molecule.

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Contact Biocatalysts' scientists to learn more about enzymes used in egg white processing or to create something bespoke to your application.

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