HybPi-Cheese: hybrid technology to decrease animal protein maintaining nutritional and sensory properties

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Consumers are not only looking for sustainable and healthy products, but also less processed ones. However, plant-based cheese alternatives are at present highly processed and lacking in nutritional and sensory properties. One innovative process to meet these requirements is to produce a hybrid product using minimally processed lupin seeds. By adding different concentrations of milled lupin into the traditional cheese making process, we developed a hybrid product that reduces the amount of animal protein, maintains nutritional value and is sensorially appealing without the need for highly processed raw materials or the additives required for plant-based alternatives.

Lupin fermentation, solubility and synaeresis

Fermentation using our VeganMix starter culture showed a similar acidification rate when mixing different amounts of milled lupin with milk as seen in Figure 1.

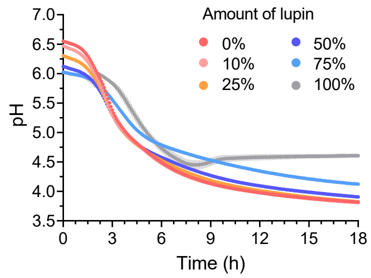


Figure 1. pH curve of the different concentrations of lupin mixed with milk, as controls pure milk and pure lupin were used.

Micro (5 ml) and a mini (20-250 ml) cheese models were employed to investigate solubility, coagulation and syneresis of the milk-lupin mixes.

Milled lupins mixed well with milk even at high percentages. By comparison, mixing 10 % of a lupin protein isolate resulted in clear sedimentation as shown in Figure 2.

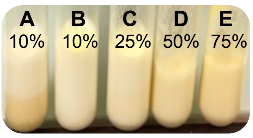


Figure 2. A, 10 % of lupin protein in milk; B-E, x % of milled lupin in milk.

Coagulation properties were lost when using more than 25% of lupin. To further understand how this process deviates from milk, we measured the elasticity index of the milk-lupin mix (Figure 3). Using 25% of lupin, coagulation occurred early and solidity was lower than with milk. By adding 0.1% of $CaCl_2$ to the mixed sample coagulation started within 10 min and firmness increased.

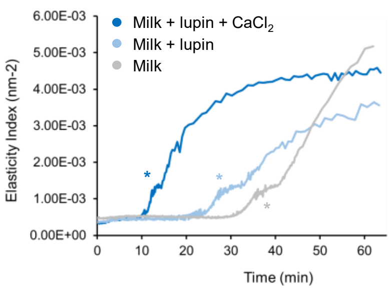
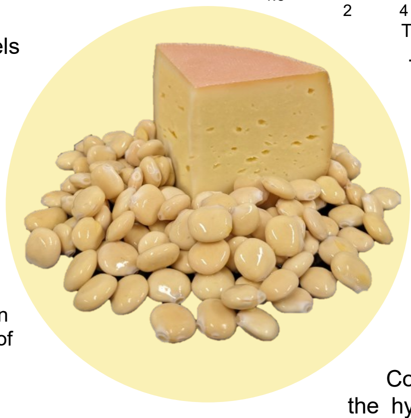


Figure 3. Rheological properties measured after addition of rennet and starter culture. Asterisks indicate coagulation points of each sample.



Upscaling the process – the Hybrid lupin cheese

Based on our previous findings, the production of the HybPi-cheese (30 L, "Mutschli" variety) was done using 7, 15 and 25% of milled lupin. During production, acidification rate was very similar between the HybPi- and the pure milk cheese (Figure 4).

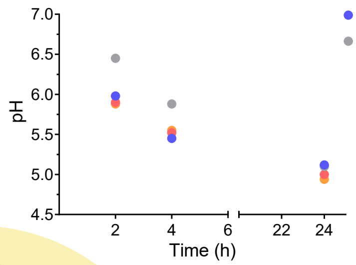


Figure 4. pH measurements of the HybPi-cheese production using 25 % of milled lupin and controls.

To determine the aroma profile differences after cheese ripening, DHS-VITEX-GC-MS analysis was performed. The different compounds that make up the aroma profile of the samples are listed in Table 1. The HybPi-cheeses had generally higher concentration of volatiles in contrast to the cheese.

The large quantities of carboxylic acids and esters support the hypothesis that adding 25 % of lupin resulted in a faster maturation process.

Consumers were not able to distinguish between the hybrid product (~15 % of lupin) and the original cheese product.

Table 1. Aroma profile after 8 weeks of ripening. Heatmap: normalized values over 1 for each compound, normalization was carried out on 8 cheeses.

Odor	Compound name	Functional group	100% Milk		25% Lupin	
			EH1	EH2	EH5	EH6
Malty/ chocolate	2-methylbutanal	Aldehyde	1.00	0.61	0.00	0.00
	3-methylbutanal		0.50	0.24	0.34	0.40
	2,6-dimethylpyrazine	Pyrazine	0.24	0.23	1.00	0.57
	Trimethylpyrazine		0.62	0.77	0.68	0.49
Creamy	Delta decalactone	Lactone	0.66	0.56	0.78	0.55
Pungent, cheesy, vinegar/acidic	Acetic acid	carboxylic acid	0.26	0.28	1.00	0.62
	Propanoic acid		0.18	0.26	1.00	0.77
	2-methylpropanoic acid		0.04	0.06	1.00	0.54
	Butanoic acid		0.21	0.18	1.00	0.68
	3-methylbutanoic acid		0.10	0.11	1.00	0.64
	Pentanoic acid		0.21	0.23	1.00	0.76
	4-methyl pentanoic acid		0.32	0.23	1.00	0.89
Buttery	2,3-butanedione	Ketone	0.17	0.11	0.34	1.00
	2,3-pentanedione		0.24	0.18	0.56	0.65
	Acetoin		0.25	0.18	0.19	1.00
Cheesy	2-heptanone	Ketone	1.00	0.74	0.30	0.16
	2-Nonanone		0.69	0.58	0.45	0.18

Conclusions & Outlook

1. The hybrid-cheese production was achievable using up to 25% of lupin and by adding $CaCl_2$, yet further process optimization of the milled lupin is needed, particularly due to sedimentation.

2. The addition of lupins resulted in higher water content and consequently faster maturation and higher salt uptake. After adapting the process, the best lupin/milk ratio was 15/85 %, which had an overall good acceptance in a small consumer test.

3. The content and composition of proteins and dietary fibres from lupin should be analysed in the hybrid product in order to assess the influence on nutritional properties. The actual amount of lupin in the end product remains unknown.

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