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Valorization of Faba Bean (*Vicia faba* L.) as a Plant Protein Source in the Production of Pork Liver Sausage

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Abstract:
The paper analyzes the use of plant proteins as partial replacers of animal raw materials in processed meat products. Proteins from soy, wheat, pea and other legumes are added to emulsified, ground and injected meat products for their water binding, emulsifying and gelling properties, and they also raise processing yield and lower costs. Their effect on nutritional quality depends on the source and the level of addition, because the essential amino acid profile of plant proteins differs from that of meat protein.

In industrial practice, hydrated textured plant proteins usually replace 10–30% of the lean meat in ground meat products, and soy protein isolates replace more than 15% of the lean meat in emulsified products.

Faba bean (Vicia faba L.) contains 25–35% protein, 50–55% carbohydrates, 7–10% dietary fiber and 1–2% fat on a dry matter basis, and its protein is rich in lysine and low in sulfur amino acids. It also contains antinutritional compounds (tannins, phytic acid, trypsin inhibitors, vicine and convicine), which soaking, boiling and dehulling reduce. Faba bean ingredients bind water, emulsify fat and form heat-set gels, so they fit the fine matrix of comminuted offal products.

The main objective of this study was to replace part of the pork liver and lungs with faba bean in lebăr, a traditional Romanian liver sausage made from boiled pork offal, back fat and rind. Four samples were produced: a control (LM) made only from animal raw materials and three variants in which 10%, 20% and 30% of the liver and lungs were replaced with faba bean (L10, L20, L30). The beans were soaked for 12 h, boiled for 60–90 min, dehulled and finely ground. The boiled offal, back fat and rind were minced, bowl chopped with the bean paste and cooking broth, stuffed into casings and pasteurized to a core temperature of 72 °C.

*Moisture, fat, protein, NaCl and ash were determined by standard methods, carbohydrates and energy value were calculated according to Regulation (EU) No 1169/2011, fat freshness was checked with the Kreiss reaction, color was measured in the CIE L*a*b* system, and 20 panelists scored the samples on a 20-point scale. As the faba bean level increased, fat content fell from 20.15% in LM to 15.42% in L20 and 12.87% in L30, and energy value fell from 246.38 to 215.62 and 198.47 kcal/100 g. Protein rose from 14.82% to 18.91% and moisture from 65.42% to 68.74%. All samples met the limits of Romanian Order No. 210/2006 for cooked meat products (water max. 75%, fat max. 30%, NaCl max. 2%, protein min. 9%), and the Kreiss reaction was negative. Faba bean made the sausage lighter (L* from 56.38 to 63.47) and less red (a* from 7.85 to 4.23). L20 received the highest sensory score (19.30 of 20 points) and the best mean score for every attribute, while the control scored lowest (16.90).*

The results show that replacing 20% of the liver and lungs with faba bean gives the best balance between composition and sensory quality, with 23.5% less fat and 12.5% less energy than the control. Further work should cover microbiological stability during shelf life, instrumental texture and consumer acceptance.

Keywords: *faba bean, plant protein, liver sausage, meat products, fat reduction*

Introduction

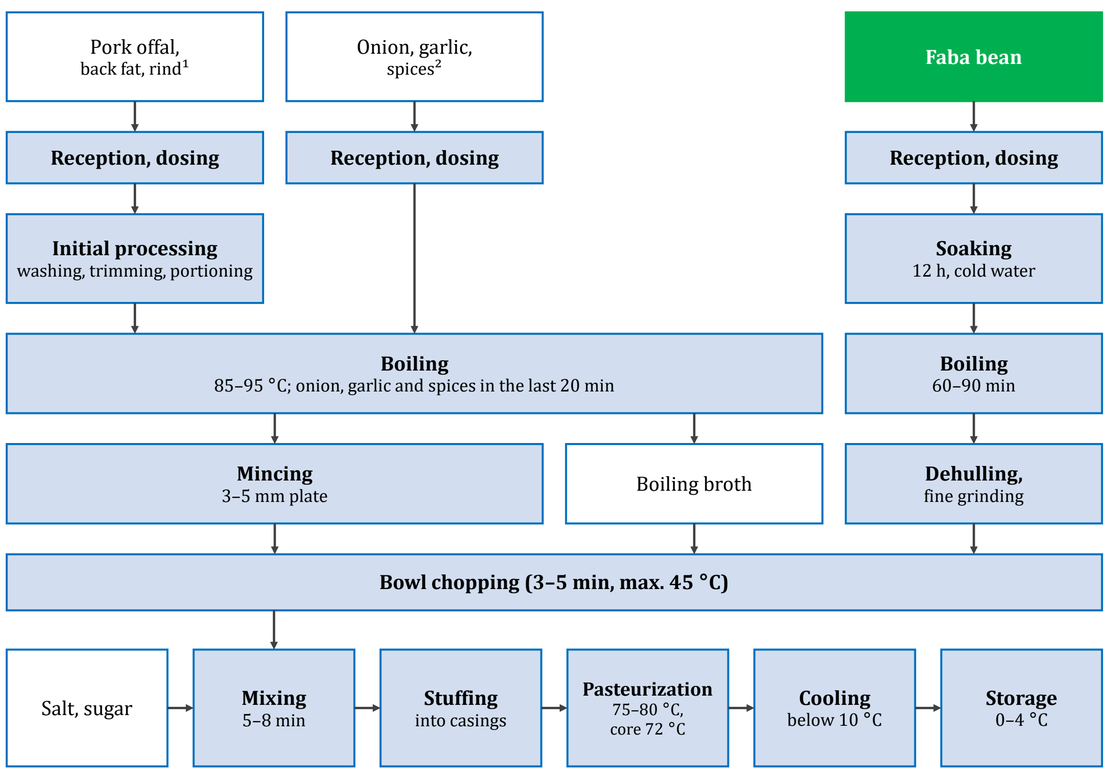
Besides meat, fat and offal, meat products contain non-meat ingredients that stabilize the mixture and give specific flavors. Plant proteins from soy, wheat, pea and other legumes are used as extenders: they bind water, emulsify fat and form gels, and they raise protein content and processing yield while lowering costs. Hydrated textured plant proteins usually replace 10–30% of the lean meat in ground products.

Faba bean (*Vicia faba* L.) is an annual legume of the Fabaceae family. It contains 25–35% protein, 50–55% carbohydrates, 7–10% dietary fiber and 1–2% fat on a dry matter basis, and its protein is rich in lysine and low in sulfur amino acids. Its antinutritional compounds (tannins, phytic acid, trypsin inhibitors, vicine, convicine) are reduced by soaking, boiling and dehulling. Faba bean ingredients bind water, emulsify fat and form heat-set gels.

Lebăr is a traditional Romanian cooked liver sausage made from pork offal, back fat and rind. The objectives were: (i) to establish recipes for lebăr with faba bean; (ii) to obtain lebăr with different levels of faba bean; (iii) to characterize the samples from a sensory, physico-chemical and colorimetric point of view.

Material and method

The base recipe contained pork liver (300 kg), lungs (150 kg), heart (100 kg), rind (100 kg), back fat (200 kg) and boiling broth (100 kg), seasoned with onion, garlic, black pepper, allspice, thyme, salt and sugar. Four samples were produced: a control made only from animal raw materials (LM) and three variants in which 10%, 20% and 30% of the liver and lungs were replaced with faba bean (L10, L20, L30). The beans were soaked in cold water for 12 h, boiled for 60–90 min, dehulled and finely ground into a paste. The technological flow is shown in Figure 1.



[1] *pork liver, lungs and heart, back fat, rind;* [2] *black pepper, allspice, thyme*

Figure 1. Technological flow for obtaining lebăr with faba bean

Analytical methods

Physico-chemical analysis was performed according to the following methods: moisture (ISO 1442:1997); fat (SR ISO 1444:2008, Soxhlet); protein (SR ISO 937:2007); NaCl (Mohr method, STAS 9065/5-1973); fat freshness (Kreiss reaction, STAS 9065/10-75); carbohydrates and energy value calculated according to Regulation (EU) No 1169/2011 (1 g fat = 9 kcal; 1 g protein or carbohydrate = 4 kcal).

Color was measured in the CIE L*a*b* system according to SR EN ISO 11664-4:2011 (Konica Minolta CM-5, D65, 10°) on fresh cross-sections at 4 °C, in 5 points per sample. Sensory analysis followed STAS 12656-88: 20 panelists scored external appearance (0–3), cross-section (0–5), consistency (0–3), taste (0–5) and odor (0–4), for a maximum of 20 points.

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Results and discussions

Proximate composition

Table 1. Physico-chemical composition of the lebăr samples

Sample	Physico-chemical parameters						
	Moisture (g/100 g)	Protein (g/100 g)	Fat (g/100 g)	NaCl (g/100 g)	Ash (g/100 g)	Carbo-hydrates (g/100 g)	Energy value (kcal/100 g)
LM	65.42	14.82	20.15	1.58	0.68	1.82	246.38
L10	66.18	16.14	17.84	1.63	0.79	2.04	231.74
L20	67.35	17.53	15.42	1.67	0.91	2.28	215.62
L30	68.74	18.91	12.87	1.72	1.04	2.53	198.47
MLA	≤ 75	≥ 9	≤ 30	≤ 2	–	–	–

LM – control; L10, L20, L30 – 10%, 20%, 30% of liver and lungs replaced with faba bean; MLA – maximum/minimum limit accepted by Order No. 210/2006

All samples met the limits of Order No. 210/2006 for cooked meat products, and the Kreiss reaction was negative in every sample. Each step of substitution lowered fat and energy value and raised protein, moisture, ash and carbohydrates. Compared with LM, L20 had 23.5% less fat and 12.5% less energy, and L30 had 36.1% less fat and 19.4% less energy.

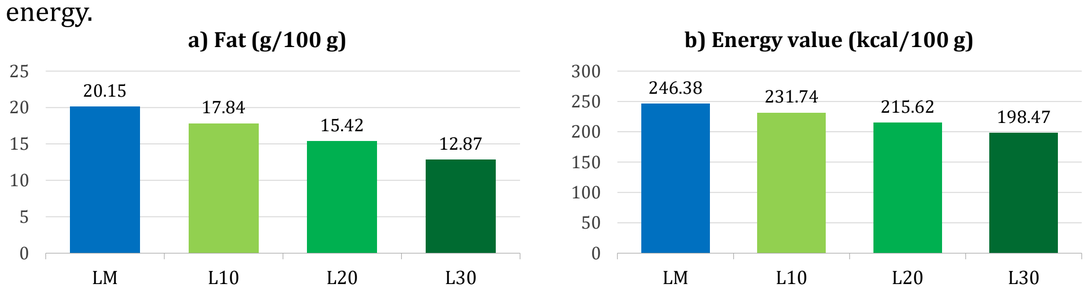


Figure 2. Fat content and energy value of the lebăr samples

Instrumental color

Faba bean made the sausage lighter and more yellow and reduced its redness, because the bean paste dilutes the heme pigments of liver and offal. L* rose from 56.38 to 63.47 and b* from 13.82 to 17.71, while a* fell from 7.85 to 4.23.

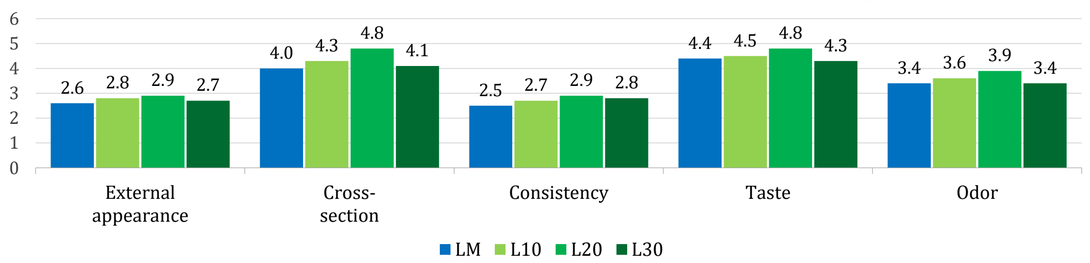
Table 2. CIE L*a*b* color parameters of the lebăr samples

Parameter	LM	L10	L20	L30
L*	56.38	58.92	61.14	63.47
a*	7.85	6.62	5.41	4.23
b*	13.82	15.04	16.38	17.71

Sensory evaluation

L20 had the highest total score (19.30 of 20 points) and the best mean for every attribute, followed by L10 (17.90), L30 (17.10) and LM (16.90). The lighter color of the samples with moderate bean levels raised the appearance scores. The legume note was subtle in L10 and L20 and more noticeable in L30, and the bean samples were slightly firmer because plant proteins gel more strongly.

Figure 3. Mean sensory scores by attribute (maximum: 3, 5, 3, 5 and 4 points)



Conclusions

Lebăr in which 10–30% of the liver and lungs were replaced with faba bean met the limits of Order No. 210/2006, with a negative Kreiss reaction. As the bean level increased, fat and energy value fell and protein, moisture and minerals rose. Replacing 20% gave the best balance: 23.5% less fat and 12.5% less energy than the control and the highest sensory score (19.30 of 20 points). Further work should cover microbiological stability during shelf life, instrumental texture and consumer acceptance.