Extrusion of Pulses for the Production of Meat Analogues

Relevant for: Farinograph, ViscoQuick, TwinLab-F 20/40, Meat Analogues, Pulse Flours, Air Classification

This study explores the potential of pulse flours as prime candidates for meat analogue production using extrusion technology. Focused on air-classified protein-enriched fractions, our research highlights a promising opportunity for the food industry to advance in sustainable and nutritious alternatives.

Figure 1: Farinograph from Brabender

1 Introduction

The meat alternative sector is experiencing notable growth, offering a significant opportunity for the food industry. With an increasing consumer demand for sustainable alternatives that replicate the sensory attributes of meat, extrusion has emerged as a pivotal technology in the production of these substitutes. Conventionally, protein isolates and concentrates have been the primary raw materials. However, their production processes often entail environmental concerns and yield products with nutritional imbalances.

In this context, protein-enriched fractions derived from pulses present a compelling alternative. These fractions, obtained through air-classified pulse flours, offer a sustainable and potentially more nutritionally balanced raw material for the extrusion-based manufacturing of meat alternatives.

Figure 2: ViscoQuick from Brabender

Figure 3: TwinLab-F 20/40 from Brabender

2 Experimental

2.1 Materials

For our research, we used four pulse flours obtained through air classification.

Samples	Proteins	Carbohydrates	Fiber	Fat
Chickpea	37	25	15	12
Red Lentil	51	20	13	4
Yellow Pea	52	15	17	5
Fava Bean	58	7.5	14	5

Table 1: Chemical composition (g/100g d.b.)

2.2 Methods

Exploring the fundamental aspects crucial for formulating and producing high-quality meat analogues, this examination offers a comprehensive overview of essential properties. The assessment includes mixing properties through the utilization of the Farinograph from Brabender® (1) (Figure 1), offering insights into the rheological characteristics crucial for processing. Furthermore, attention is given to pasting properties, evaluated using the ViscoQuick from Brabender® (1) (Figure 2), providing a detailed understanding of the paste consistency under varying conditions.

In addition, functional properties, including water and oil absorption, as well as foaming and emulsion properties, are systematically analyzed (2). This multifaceted exploration aims to elucidate the behavior of the material in diverse culinary applications, ensuring optimal performance and consumer satisfaction.

A distinctive focus is dedicated to high-moisture extrusion, conducted using the TwinLab-F 20/40 from Brabender® (see Figure 3). This advanced extrusion technology plays a pivotal role in shaping the textural and structural attributes of meat analogues.

3 Results and Discussion

The increase in thickness noticed after air classification is because the protein content went up at the same time. Conversely, chickpea samples exhibit a diminished consistency relative to their air-classified counterparts. This implies a nuanced influence of air classification on the textural attributes of various pulse-based samples, with chickpeas manifesting a distinct reduction in consistency (see Figures 4 and 5).

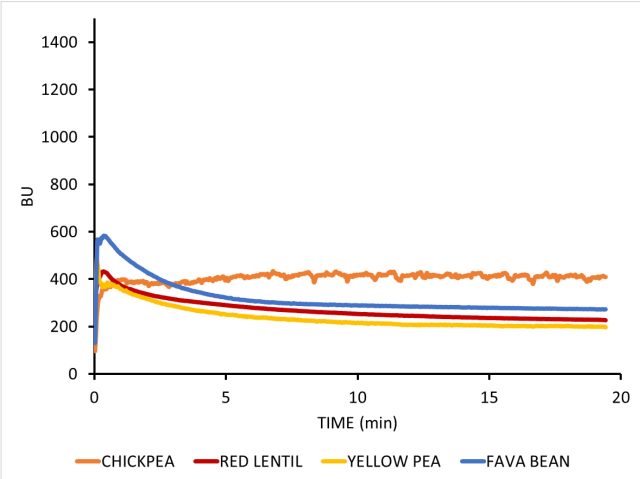

Figure 4: Farinograph charts (constant hydration of 50 %) of pulse flours before air classification

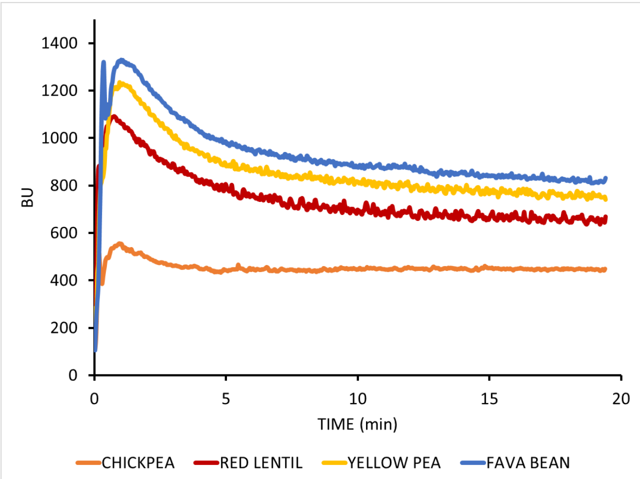

Figure 5: Farinograph charts (constant hydration of 50 %) of pulse flours after air classification

Exploring the texture dynamics of pulse flours, red lentil distinguishes itself with the highest observed viscosity (see Figure 6). The analysis extends to protein-enriched flours, elucidating their consistent low pasting properties. Noteworthy findings emerge when subjecting these flours to air classification, with both red lentil and yellow pea exhibiting the highest viscosity among the samples (see Figure 7).

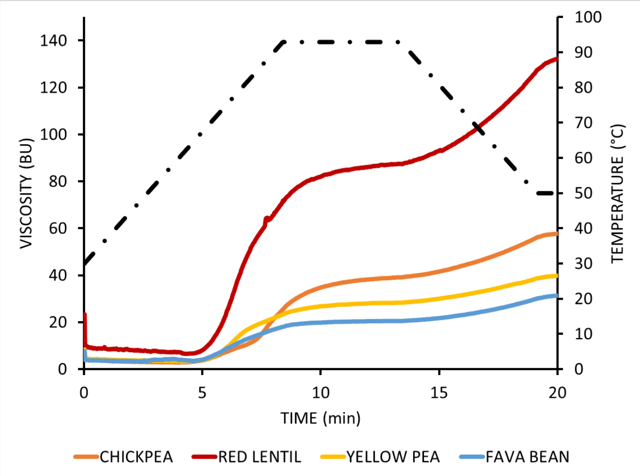

Figure 6: Pasting properties (10 g in 105 ml of H_2O) of pulse flours before air classification

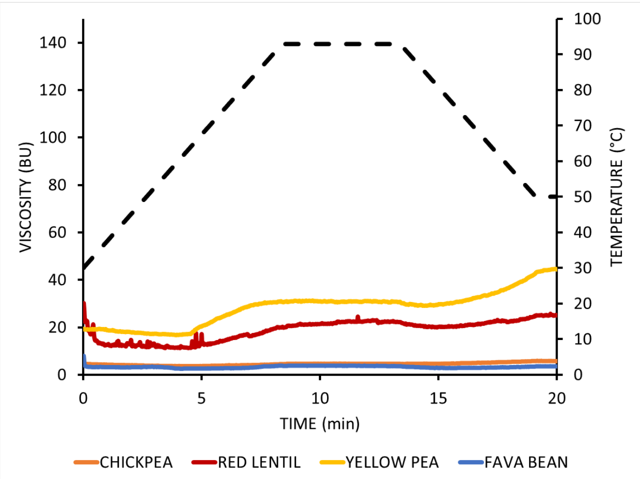

Figure 7: Pasting properties (10 g in 105 ml of H_2O) of pulse flours after air classification

The behavior in water absorption, oil absorption, and emulsifying capacity is similar for all different samples. Highlighting distinct attributes, red lentils demonstrate high foaming activity, whereas fava beans exhibit comparatively lower foaming stability.

Chickpea is unsuitable for meat analogue production due to its low protein and high fat content. Red lentils exhibit poor protein texturization. Yellow pea demonstrates intermediate behavior in terms of protein characteristics. Fava bean yields the best results, attributed to the formation of well-texturized proteins (see Figure 8 – 11)

Figure 8: Chickpea

Figure 9: Red lentils

Figure 10: Yellow Pea

Samples	H_2O absorption (g/ml)	Oil absorption (g/ml)	Foaming activity (%)	Foaming stability (%)	Emulsion activity (%)	Emulsion stability (%)
Chickpea	1.6 A	2.2 B	65 AB	96 B	43 A	39 A
Red lentil	2.0 B	2.1 AB	78 C	98 B	40 A	41 A
Yellow pea	1.8 AB	1.9 A	66 B	96 B	43 A	42 A
Fava bean	1.8 AB	2.1 AB	63 A	92 A	42 A	43 A

Table 2: Functional properties of raw materials. Different letter in the same column mean significant differences ($p<0.05$, Tukey's HSD)

Figure 9: Fava bean

4 Summary

In terms of texturizing properties, the pulses are ranked as follows: fava bean demonstrates the highest texturizing capability, followed by yellow pea, red lentil, and lastly, chickpea, which exhibits the least favorable texturizing properties among the evaluated legumes.

5 References

1. **A. Bresciani, D. Emide, F. Saitta, D. Fessas, S. Iametti, A. Barbiroli, A. Marti.** *Molecules*, 27(4), 1266, 2022

2. **A. Bresciani, G. Cardone, C. Jucker, S. Savoldelli, A. Marti.** *Insects,* 13,546, 2022

Contact Anton Paar GmbH

Tel: +43 316 257-0

Application-tex@anton-paar.com | www.anton-paar.com