

Processing influences the amount of resistant protein in soybean meal

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Background and objective: Reducing protein fermentation, by minimizing resistant protein that escapes digestion and is fermented in the lower gastrointestinal tract (GIT), will decrease diarrhea incidences and inhibit pathogenic bacteria proliferation, especially during post-weaning stress in piglets (Rist et al., 2013). The objective of the study is to evaluate the effect of different type of SBM processing, either thermo-mechanical, enzyme-facilitated (TEP) or extensive extraction as done in soy protein concentrate processing (SPC), on *in vitro* digestion of protein and reducing the amount of resistant protein.

Materials and methods: The study evaluated 3 batches of TEP (AlphaSoy – 52% CP, Agilia a/s, Videbaek, Denmark) and 3 different sources of SPC (60% CP on average). The study used a modified two-step *in vitro* model as described by Boisen and Fernández, 1995. Samples were incubated in triplicate sequentially with pepsin at pH 3.5 for 1.5 hour (stomach phase) and with pancreatin and bile extract at pH 6.8 for 0, 0.5, 1, 2, 4 and 6 hours (small intestine phase). In addition, crude protein was classified into CP_{fast}, CP_{slow} and CP_{resistant} corresponding to digested CP (% of total CP) within the first 0.5 hours, from 0.5 to 4 hours, and more than 4 hours, respectively.

Results: *In vitro* digestion of protein in TEP was greater ($P < 0.0001$) than in SPC at each time point. After 6 hours of incubation with pancreatin and bile extract, *in vitro* digestibility of CP was greater ($P < 0.0001$) in TEP than SPC (81 vs. 63%). According to predicted equations, time to reach maximum protein digestion was longer in SPC than TEP (6 vs. 4 hours; Figure 1). In TEP the amount of resistant CP was 50% lower than with SPC ($P = 0.012$, Table 1).

Table 1. Effect of processing (thermo-mechanical and enzyme-facilitated processing (TEP) vs. extensive extraction to produce soy protein concentrate (SPC)) on the content of fast-digested CP (CP_{fast}), slow-digested CP (CP_{slow}) and resistant CP (CP_{resistant}) in SBM¹

| | TEP | SPC | SEM | P-value Processing |
|-----------------------------------|-------------------|-------------------|------|--------------------|
| CP _{fast} , % | 64.1 | 44.4 | 7.11 | 0.122 |
| CP _{fast} , g/kg DM | 343 | 284 | 44.0 | 0.400 |
| CP _{slow} , % | 9.46 | 12.1 | 4.53 | 0.706 |
| CP _{slow} , g/kg DM | 50.6 | 80.1 | 29.1 | 0.513 |
| CP _{resistant} , % | 26.4 ^a | 43.5 ^b | 3.46 | 0.025 |
| CP _{resistant} , g/kg DM | 141 ^a | 280 ^b | 22.7 | 0.012 |

¹Protein were classified into CP_{fast}, CP_{slow} and CP_{resistant} corresponding to digested CP (% of total CP) within the first 0.5 hours, from 0.5 to 4 hours, and more than 4 hours, respectively.

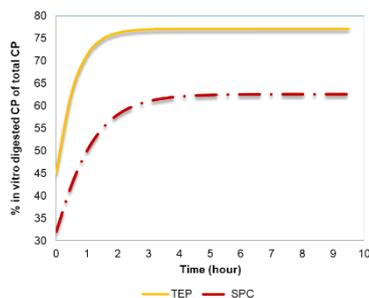


Figure 1. *In vitro* digestion of protein at small intestine in thermo-mechanical and enzyme-facilitated processed soy protein (TEP) and soy protein concentrate (SPC) followed Gompert-fuction model: $Y = 77.2 \times (0.582 \exp(-e^{0.70 \times \text{Time}}))$ and $Y = 62.6 \times (0.512 \exp(-e^{0.40 \times \text{Time}}))$, respectively.

Conclusion and discussion: Extensive extraction to producing SPC resulted in a higher but also more resistant content of CP than the TEP procedure. According to Wilson and Leibholz (1981), digesta retention time in 14-35 day old piglets fed milk or soy protein diets is 16-56 min in the duodenum and jejunum and 93-157 min in the ileum. Although digestion of protein is slower *in vitro* than *in vivo*, our results indicated that protein would be digested faster with increased chance of amino acid absorption in the jejunum in TEP than SPC protein. This indicates that less protein from TEP will reach the lower part of the GIT thereby reducing protein fermentation. In conclusion, thermo-mechanical, enzyme-facilitated processing of SBM is more efficient in reducing resistant CP in comparison with extensive extraction. Resistant CP is a potential simple characteristic to evaluate protein quality of feed ingredients.

References:

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