



Effect of temperature, moisture and sunflower oil content, on the functional properties of an extruded bovine cattle feed

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Introduction. The production of extruded products with high oil content presents a technological challenge as it reduces the specific mechanical force, acts as a lubricant and forms complexes with starch (1), thus limiting its gelatinization (2). The objective of this research was to evaluate the effect of temperature, moisture and oil content on a cattle feed extrusion process.

Methods. The diets were balanced in accordance to their ingredients' chemical proximal analysis. A blocked factorial design ($2^3 \times 3^3$) was used, including alfalfa (*Medicago sativa* L.) and waste bean (*Phaseolus vulgaris* L., also known as "granza") content as variables, as well as extrusion temperature (12, 135 and 150 °C), moisture (14, 16 and 18 %) and oil content (0, 3.5 and 7 %), having responses such as expansion index (EI), water absorption index (WAI), water solubility index (WSI), hardness (H), and apparent density (AD). Optimizations using quadratic regressions according to the products' desired physicochemical characteristics were performed. For the six diets, optimal process conditions were obtained, and, for each optimal treatment, *in vitro* digestibility (3) and *in situ* digestibility (3) were performed.

Results. The obtained results indicate that increasing temperature, moisture and oil content, AD and H, decreased ($p < 0.05$) (4). The synergy between oil content-temperature, increased both responses, and the synergy of oil content-moisture, increased only hardness. Optimal process conditions for the bean treatments were: 0% of sunflower oil content, temperature of 121.1 °C and 14% of moisture content; 3.5 % of oil content, temperature of 120 °C and 16% of moisture content; and, 7% of oil content, temperature of 141.17 °C and 15.5 % of moisture content with the following responses: H: 50, 49.7 and 50 N; EI: 1.09 , 1.02 and 1.07; AD: 1125, 1121.34 and 1101.02 kg/m³; WAI: 2.34 , 2.26 and 2.27 g/g, and, WSI: 12.15 , 11.97 and 11.63 %, respectively. All our diets have a high In Vitro Digestibility (IVD) between 80-95% compared with alfalfa (60%)., Reyes (2011) found in comercial diets in IVD 85%.

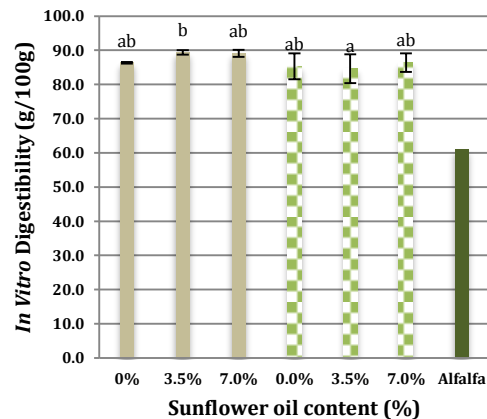


Fig.1. *In vitro* Digestibility (DIV) results for both diets, and the three concentrations of sunflower oil (0, 3 and 7%), solid color= bean diets, chess theme= alfalfa diets. Same letters means no significative difference ($P > 0.05$)

Conclusions. Lipids presence change the gelatinization mechanism by forming starch-lipids complexes, thus reducing water absorption in the granule. Starch-lipid complexes compete for water availability, hence, increased gelatinization temperature. We also found that the synergies of oil content – temperature and oil-moisture content increased the aforementioned responses (5). The extruded diets shown a IVD average 86.9 ± 2.10 %.

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