Extrusion as a functional measure for increasing the biological value of plant origin rest raw materials to produce meat analogues.

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Objectives: The aim of this research was to validate the modified extrusion process as a measure for improving the biological value of soy and oat press cakes from plant-based drinks' manufacturing process and investigating the biochemical and antinutrient content of raw materials to produce meat analogue products.

Materials & Methods: Soy and oat press cake samples were hydrated to 30% or 60% respectively before processing. Samples were then allowed to equilibrate overnight at 4 °C, and later extruded using a twinscrew extruder. Extrusion was carried out under four different conditions for each raw material by varying processing temperature and initial sample moisture. Biochemical analyses (biogenic amine content, raw protein content, fat content, total fiber content, and carbohydrate content) of samples were conducted using respective ISO and/or AOAC certified methodologies. Trypsin inhibitor activity was assessed by the method described by Smith et. al. (1980.)

Results: Total fatty acid content, ash content, protein, salt, fiber, and nitrogen content in both Oat and Soy press cakes were comparable to that of pork ham. $Oat_{control}$ press cake contained the highest amounts of isoleucine (5,82%), tryptophan (4,66%), valine (4,25%) and phenylalanine (3,1%), which are comparable to levels listed for pork in literature. Other essential amino acids such as histidine, threonine, methionine, lysine, and leucine were also found in significant amounts between 2,54% and 1,64%. However, essential amino acids in $Soy_{control}$ press cakes were found in concentrations lower than in pork ham. The application of higher extrusion temperature had a negative impact on the levels of select amino acids, as abundant essential amino acids in all oat samples after extrusion decreased as follows: isoleucine - up to 4 times, tryptophan - 3,5 times, valine - 4,2 times, and phenylalanine - 2,5 times. However, amino acid reduction in all extruded soy samples was not as significant as with all extruded Oat samples. On the other hand, extrusion process resulted in the increase of a couple of amino acids: In oat samples, histidine increased by 0,85% and methionine by 0,42% in total. Peroxide content was detected below 20 μg/kg in all samples. An increase in cadaverine, putrescine and tyramine were observed only in $Soy_{60\%,110°C}$ sample. Histamine content was detected below 5 mg/kg in all Oat and Soy samples, but in $Soy_{30\%,120°C}$ sample it was detected up to 46 mg/kg. Due to high moisture and temperature, sugar levels also increased after extrusion. $Oat_{30\%,110°C}$ sample had up to 64% higher sugar amount and $Soy_{30\%,120°C}$ sample reported a 10-fold increase in total sugar amount. In $Oat_{30\%,120°C}$ sample, fiber content after extrusion increased up to 3 times but in $Soy_{60\%,120°C}$ sample the total fiber content decreased by almost half. In all extruded oat samples, fat content increased by 3-4 times, whereas in $Soy_{30\%,110/120°C}$ samples fat con- tent was up by 30% but in $Soy_{60\%,110/120°C}$ samples total fat decreased by 35%. Ash content in all oat samples increased up to 3 times, but in all soy samples it remained mostly stable. Extrusion had an impact on trypsin inhibitor levels. In all oat samples, around

<10% decrease in trypsin inhibitor levels was reported but in $Soy_{60\%,110°C}$ sample a decrease of almost 70% in trypsin inhibitor levels was reported.

Conclusions: Our results show significant changes in biogenic amines' content due to modulation of physical process parameters (temperature and pressure) during extrusion process in the production of soy and oat extrudates. These results also corroborate the findings of Stadler, R., et al. who showed an increase in acrylamide content in press cakes with increasing temperature (from undetected to almost 49 μg/kg concentration in $Oat_{30\%,120°C}$ and 76 μg/kg in $Soy_{60\%,110°C}$). Our research demonstrates the potential of utilizing modified extrusion process to improve the chemical properties of rest raw materials repurposed for meat analogue production. Our results also indicate the best extrusion regime for treating oat and soy press cakes to be at 30% humidity, 120°C. This process not only diminishes antinutrient activity while improving amino acids and nutritional composition, but also contributes to developing sustainable practices by utilizing rest raw materials in production. Further research utilizing other rest raw materials of plant origins (rice, almonds etc.) is necessary to improve modified extrusion process and fine tune the desired textural properties of final products.

References:

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