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Combination of amylase treatments and very low-cost extrusion cooking for ready-to-cook infant flour production in Vietnam

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"Very Low-Cost Extruders" (VLCE) have been recently developed in Vietnam to process rice-based blends with low lipid content into instant infant flours. The necessity to produce a ready-to-cook infant flour for the remote areas of the country where water is unsafe, leaded us to study the ability of these VLCE to process a rice/soybean/sesame (65.0/27.4/7.6, w/w) blend with appropriate lipid and protein contents. After extrusion cooking, the starch gelatinization rate of this blend reached 90%. Consequently, it required only a short cooking time period after reaching boiling temperature to be prepared into a gruel. However, when prepared at an appropriate energy density the viscosity of this gruel was too high to be consumed by infants and young children. Thus, in order to allow the preparation of gruels with both high energy density and adequate thin consistency, the conditions of utilization of amylase treatments in combination with extrusion cooking were studied. Two types of amylases (Termamyl 120 L in liquid form or BAN 800 MG in granulate form, both from Novo Nordisk A/D, Denmark) were incorporated into the blends before [1, 2, 3 or 5 kilo Novo Units (KNU) of Termamyl] or after (1 or 3 KNU of BAN) extrusion with the particular aim to study their effects on starch gelatinization rate and carbohydrate composition of extruded blends and rheological behavior and osmolality of gruels. Gruels prepared with high dry matter content (20%) from blends with at least 3 KNU of Termamyl or 1 KNU of BAN had an appropriate viscosity. Amylase treatments had no effect on the osmolality of gruels which remained at an acceptable level ($\tilde{8}$0 mOsm/kg H2O). Termamyl treatment modified only slightly water soluble dextrin and oligosaccharide (DP<8) contents. However, small residual amylase activities were found in the Termamyl treated extruded blends probably because of their short residence time ($\tilde{1}$5 seconds) in VLCE. Consequently, further studies are necessary to define conditions of inactivation of residual Termamyl in extruded blend before using Termamyl treatment in combination with very low-cost extrusion cooking With regards to BAN addition into VLCE extruded flours, it seems to be a promising process for ready-to-cook flour production in Vietnam and other developing countries.
Keywords: extrusion cooking, ready-to-cook flour, amylase, viscosity, energy density

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Abstract
"Very Low-Cost Extruders" (VLCE) have been recently developed in Vietnam to process rice-based blends with low lipid content into instant infant flours. The necessity to produce a ready-to-cook infant flour for the remote areas of the country where water is unsafe, led us to study the ability of these VLCE to process a rice/soybean/sesame (65.0/27.4/7.6, w/w) blend with appropriate lipid and protein contents. After extrusion cooking, the starch gelatinization rate of this blend reached 90%. However, when prepared by short cooking at an appropriate energy density, the viscosity of the gruel was too high to be consumed by young children. Therefore, two types of amylase were added to the blend, before (Termamyl) or after (BAN) extrusion, with the aim to study their effects on the carbohydrate composition of extruded blends and the rheological behaviour of gruels. Gruels prepared with high dry matter content (20%) from blends with at least 3 KNU (kilo Novo Units) of Termamyl or 1 KNU of BAN had appropriate viscosity. However, small residual amylase activity was found in the Termamyl extruded blends. BAN addition combined with VLCE treatment seems to be promising for the production of ready-to-cook flour in Vietnam and other developing countries.
Keywords: *extrusion cooking, ready-to-cook flour, amylase, viscosity, energy density*

Introduction

Amylase incorporation into infant flour is one of the most effective ways to reduce the viscosity of gruels (Trèche, 1995). The use of "low-cost" extrusion cooking for infant flour production was recommended from the 60s (Harper et Jansen, 1985). In Vietnam, Fasevie program with the collaboration of the Centre for Technology Transfer and Consultancy on Investment (CTC) of Post Harvest Institute designed a "very low-cost" extruder that can be manufactured locally for the production of rice-based instant flour, which can be used as complementary food by children living in families which are used to boil water before use (Mouquet *et al*, 2003). In order to ensure a sufficient bacteriological quality to gruels given to children living in contexts with poor hygienic conditions, it is necessary to provide their mothers with flours requiring a short cooking (5 min) before consumption. Thus, the main objective of our work was to study the possibility to combine VLCE and amylase treatments for the production of ready-to-cook infant flour.

Materials and methods

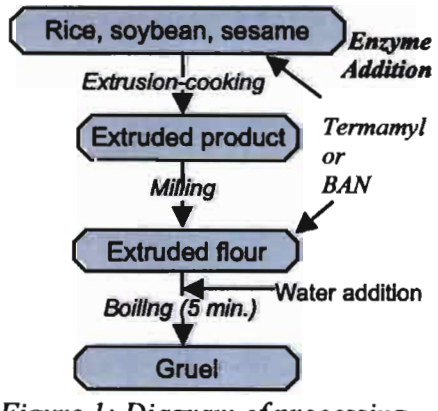

Figure 1: Diagram of processing

A blend was prepared by mixing rice, soybean, and sesame (65.0/27.6/7.4, w/w). Blend moisture was adjusted at 13% by adding water and samples were kept in plastic bags for two hours before extrusion. Termamyl 120 L in liquid form or BAN 800 MG in granulated form, both from Novo Nordisk A/D, Denmark, were incorporated into the blends either before *[1, 2, 3 or 5 kilo Novo Units (KNU) of Termamyl per 100g DM of blend]* or after *(1 or 3 KNU of BAN per 100g DM of extruded flour)* extrusion.

Extrusion was carried out with an EX800 (CTC, Vietnam) single screw extruder with 7.8 cm screw diameter and 3.5/1 screw length and diameter ratio.
The rate of starch gelatinization was measured as described by Mouquet *et al.* (2003).
Amylase activity was determined by a colorimetric method (Megazyme, Wicklaw, Ireland).
Apparent viscosity of gruel was measured using a Haake viscometer VT550 with the SV-DIN measurement system according to the method described by Mouquet and Trèche (2001), i.e. a shear rate of $83s^{-1}$, a shear time of 10min and at a temperature of 45.0±0.5°C.
Water-soluble dextrin and oligosaccharide (DP<8) contents were determined by HPIC and GPC.

Results

Effect of VLCE and amylase treatments on starch gelatinization rate and dextrinisation and on amylase inactivation

The starch gelatinization rate of all extruded blends reached 90%. Incorporation of enzyme in the raw materials before extrusion did not change the starch gelatinization rate of extruded blends. Addition of 3 KNU of Termamyl per 100g DM of blend before extrusion resulted in a 10% increase of water soluble dextrin content and a 39 % increase of oligosaccharide (DP<8) content. Traces of enzyme activity found in flours of blends extruded with ≥2 KNU of Termamyl per 100 g DM indicated that the VLCE treatment did not totally inactivate the amylase during extrusion. The short residence time (~15 seconds) of materials inside the extruder may explain this phenomenon.

Effect of VLCE and amylase treatments on the rheological behaviour of gruels

The concentration of the gruel prepared from extruded flour without amylase at a consistency suitable for young children (~2.0 Pa.s) reached about 16 g DM/100g of gruel. This value is higher than the concentration of gruel prepared from crude flour (about 9 g DM/100g) but remains well under the desirable concentration of ≥20 g DM/100g. Addition of ≥3 KNU of Termamyl per 100g of blend before extrusion and ≥1 KNU of BAN after extrusion allowed the preparation of gruels with both appropriate energy density and consistency (DM content ≥ 20 g DM/100 g and ~2.0 Pa.s)

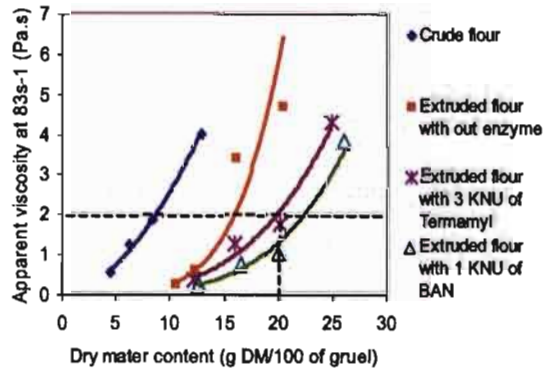

Figure 2: Apparent viscosity of gruels prepared at different concentrations

Conclusion

Using VLCE allows only a limited increase of the energy density of the gruel. To obtain gruel having a high enough energy density at a consistency suitable for young children, it is necessary to incorporate either 3 KNU of Termamyl per 100g of blend before extrusion or 1 KNU of BAN per 100 g of extruded flour.

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References

Harper, J. M., Jansen, G. R., 1985.. *Food Reviews International*, 1985, **1**, 27-97.
Mouquet, C., Salvignol, B., Van Hoan, N., Monvois, J, Trèche, S., 2003. *Food Chemistry, 2003*,**82**, 249–255.
Mouquet C, Trèche S. *International Journal of Food sciences and Nutrition*, 2001, 52, 389-400.
Trèche, S., 1995. *In* Trèche, S., de Benoist, B., Benbouzid, D., Verster, A., Delpeuch, F. éds: *L'alimentation de complément du jeune enfant*. Paris, 1995, Orstom, collection colloques et séminaires, 1995, 123-148.

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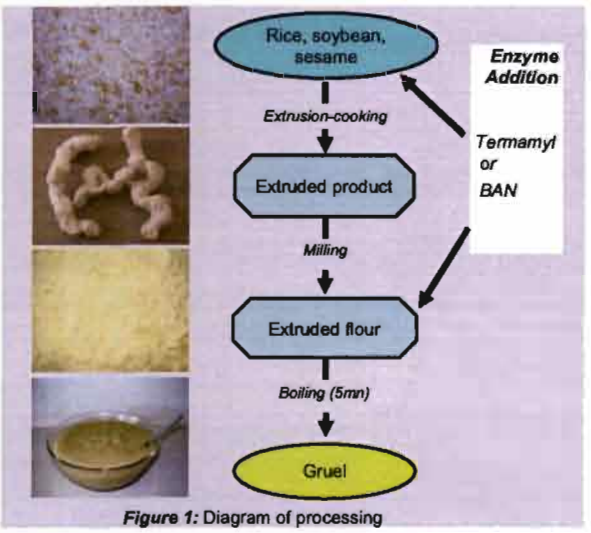
1. Motor
2. Control box
3. Feeding machine
4. Screw and cylinder
5. Cutter

Photo 1: Extruder EX800



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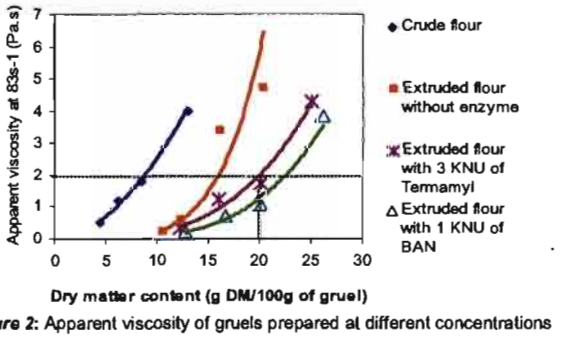

Figure 2: Apparent viscosity of gruels prepared at different concentrations

Conclusion

- Using VLCE allows only a limited increase of the energy density of the gruel.
- Gruels having a suitable consistency for young children when pre-pared at a sufficient energy density can be obtained by incorporating either 3 KNU of Termamyl per 100g of blend before extrusion or 1 KNU of BAN per 100 g of extruded flour.

Photo 2: Ready-to-cook flour based on formula of the study

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References

- Mouquet C, Salvignol B, Van Hoan N, Monvois J, Trèche S. Ability of a «very low-cost extruder» to produce instant infant flours at small-scale level in Vietnam. *Food Chem, 2003,* **82**, 249–255.
- Mouquet C, Trèche S. Viscosity of gruels for infants: a comparison of measurement procedures. *Int J Food Sci Nutr, 2001,* **52**, 389-400.