EXTRUDED WHOLE GRAIN FLOURS AS INGREDIENT FOR GLUTEN-FREE BREAD: RHEOLOGICAL EVALUATION

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ABSTRACT: Whole grain flours of maize, rice and sorghum were processed by thermoplastic extrusion at 25% of moisture and milled into pre-cooked whole grain fine flours. Their pasting and farinograph properties were determined. The modification caused by extrusion was observed through apparent curve viscosity was observed and compared to their raw profile. The farinograph consistency and water absorption (WA) capacity of the extrusion pre-cooked whole grain flours stood out considerably among the farinographic properties, evidencing the development of outstanding viscoelastic properties. The reduction in the dough development time for all extruded flours, meant low processing cost of energy leading to possible adoption as ingredient by bakery industry of gluten free breads.
Keywords: dough rheology, paste viscosity, thermomechanical process, gluten-free products, farinograph

INTRODUCTION

One problem in the evaluation of non-wheat bread and pasta products is the lack of standardized methods that allow reliable and well reproducible results. The use of a Brabender farinograph is an empirical rheological technique that measures water intake and strength of the dough has been little explored in gluten-free dough evaluation, but with some modifications it can be a useful and applicable method to determine the properties of gluten-free flours, under pre-established hydration conditions. Maize, rice, and sorghum are currently the most produced gluten-free (GF) cereal grains (FAOSTAT, 2019). Thermoplastic extrusion process efficiently modifies the plant based biopolymers thus conferring functional properties that can mimic wheat gluten (TORBICA; BELOVIC; TOMIC, 2019). The objective of this research was to evaluate the effect of the extrusion process on the apparent viscosity (paste) and farinographic properties of gluten-free whole grain flours to evidence the extrusion process on the development of viscoelastic properties that can be used as a source of whole grain pre-cooked as replacement of gluten in bakery doughs.

MATERIAL AND METHODS

Materials

Parboiled brown rice and maize grains were donated by Granfino Alimentos (Nova Iguaçú, Brazil). Sorghum grains of red pericarp of low tannin content were donated by Embrapa Milho e Sorgo (Sete Lagoas, Brazil) and commercial whole wheat flour (WWF) was acquired from the local market of Rio de Janeiro. The grains were ground: maize (WMF), parboiled brown rice (PBRF) and sorghum (WSF).

Experimental procedure

The whole grain flours were adjusted at 25% of moisture and processed in a co-rotating intermeshing twin-screw extruder HT25 Evolum (Clextral Inc., Firminy, France) at 200 rpm, equipped with ten heating zones: 25, 40, 60, 80, 100, 110, 110, 90, 80, and 70 °C and die cutter. The extrudates were dried and ground into fine flours: EWCF (maize), EPBRF (rice) and EWSF (sorghum).

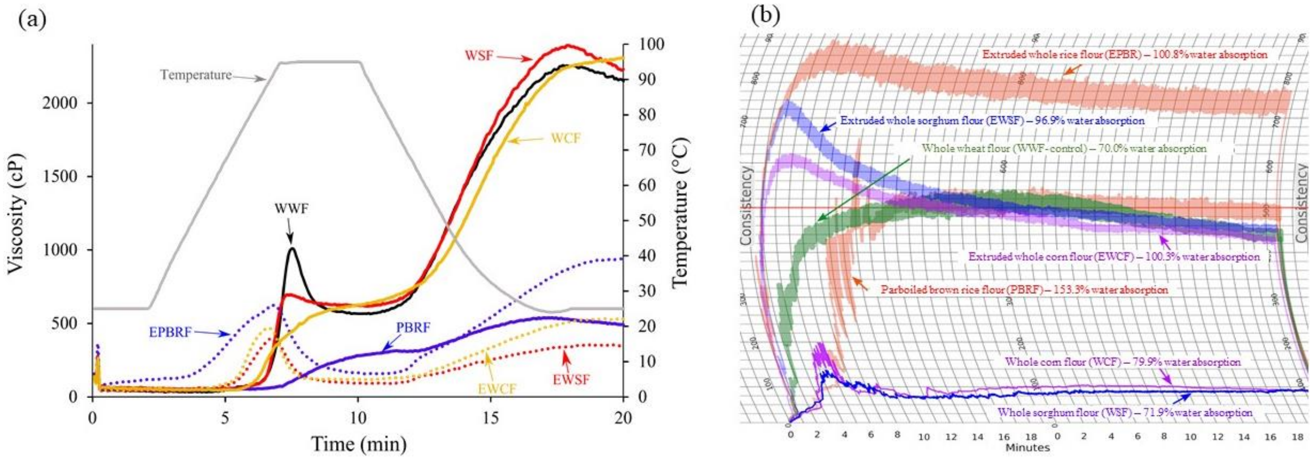
A Rapid Visco Analyzer series 4 RVA (Newport Scientific Pty Ltd., Warriewood, Australia) was used following method 76-21 (AACC, 2000). Pasting temperature (PTem), cold viscosity at the beginning 25°C (CV), peak viscosity (PV), trough viscosity or holding strength (TV), breakdown viscosity (BDV= PV-TV), final viscosity (FV), and setback viscosity (SBV= FV-TV). Farinograph method measured and recorded the resistance of the dough to the mixture using the Brabender Farinograph© (Duisburg, Germany) method 54-21 AACC (2011).

RESULTS AND DISCUSSION

The pasting viscosity profile of the raw and extruded flours are displayed in Figure 1a. The raw flours (EWCF and EWSF) without thermal treatment showed similar paste properties such as Ptem, CV, TV, and BDV, but they differed in FV and SBV. In both samples the paste properties were lower with respect to the raw samples. But PBRF showed lower SBV than those values of WCF and WSF. These reduced SBV values may be associated with the previous parboiling treatment. All the extruded flours showed similar shape in pasting curve. As a consequence of the extrusion process, the significant reduction ($p<0.05$) in the PV, TV, FV, and SBV values could be observed, as well as the consequent increase in the BDV values in EWCF and EWSF samples.

However, EPBRF whereas presenting similar reductions to EWCF and EWSF, it showed an significant increase ($p<0.05$) in PV, FV and SBV associated with the atypical increase of the granular rigidity of the starch (HOOVER; VASANTHAN, 1994).

Figure 1 – Pasting and farinographic properties of raw and extruded flours.



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From Figure 1b, it was observed the development of farinograph consistency and also a considerable increase of water absorption by the extruded flours. It should be noted, that the extruded parboiled rice sample had the highest consistency, showing that the extrusion processes associated with parboilization resulted in rice flours of great water absorption and stability. In all extruded flours, the farinographic property of dough development time (DDT) was significantly lower ($p<0.05$) compared to parboiled whole rice and commercial whole wheat flours. Likewise, extruded maize and sorghum flours presented significant increase ($p<0.05$) in the dough stability time (DST) and the mixing tolerance index, 5 min after peak (MTI) in comparison with extruded parboiled rice flour, allowing an increase of resistance to mechanical work without affecting the structure of the dough throughout GF breadmaking (CHAUHAN; ZILLMAN; ESKIN, 1992). From Fig. 1b it can seem the development of farinograph consistency and also a considerable increase of water absorption by the extruded flours. It should be noted, that the extruded parboiled rice sample had the highest consistency, showing that the extrusion processes associated with parboilization resulted in rice flours of great water absorption and stability. In all extruded flours, the farinographic property of dough development time (DDT) was significantly lower ($p<0.05$) compared to parboiled whole rice and commercial whole wheat flours. Likewise, extruded maize and sorghum flours presented significant increase ($p<0.05$) in the dough stability time (DST) and the mixing tolerance index, 5 min after peak (MTI) in comparison with extruded parboiled rice flour, allowing an increase of resistance to mechanical work without affecting the structure of the dough throughout GF breadmaking (CHAUHAN; ZILLMAN; ESKIN, 1992).

CONCLUSION

The modification caused by extrusion cooking on parboiled whole rice and whole raw corn and sorghum flours by looking at their pasting profile was evidenced. A typical decrease in all pasting properties, except to parboiled whole rice and an increase of the breakdown viscosity (BDV) were observed. Farinographic properties: consistency, water absorption (WA), dough development time (DDT), dough stability time (DST) and mixing tolerance index at 5 min after peak (MTI), dramatically changed including extruded parboiled brown rice. The reduction in dough development time for all extruded flours meant low processing and energy cost with possible adoption by the bakery industry of gluten-free products.

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