Campden BRI
Station Road
Chipping Campden
Gloucestershire
GL55 6LD, UK

Tel: +44 (0)1386 842000
Fax: +44 (0)1386 842100
www.campdenbri.co.uk

Legumes – an alternative to cereals?

Joe McGurk, Sarab Sahi and Stella Heuer
Campden BRI

Pulses, or grain legumes, are high in fibre and starch and have been found to contain twice as much protein as that of any wholegrain cereal. The pseudocereals amaranth, quinoa and buckwheat are genetically unrelated to one another but morphologically resemble true cereals.
This paper discusses the potential use of legumes and pseudocereals as alternatives to traditional wheat flour.

Joe McGurk
+44(0)1386 842241
joe.mcgurk@campdenbri.co.uk

Sarab Sahi
+44(0)1386 842140
sarab.sahi@campdenbri.co.uk

Updated: June 2017

INTRODUCTION

Legumes and pseudocereals are already widely consumed and play an outstanding nutritional role in the human diet. There is increasing interest in their applications in novel foods. They are gluten free and high in protein making them suitable for use as cereal substitutes in many vegetarian and gluten-free products. They are also rich in vitamins and minerals and, when blended with wheat, legumes and pseudocereals can be used to enhance the nutritional content of products and provide amino acids that are lacking in cereals. They also have applications for formulated products, starch extracts, flour, thickening agents, protein concentrates, weaning food, and whole seeds.
At Campden BRI, we've been investigating the potential applications of cereal alternatives - exploring the functional characteristics of the starch in different pseudocereals and pulses to better understand to which applications they might be most suited.

FUNCTIONAL PROPERTIES

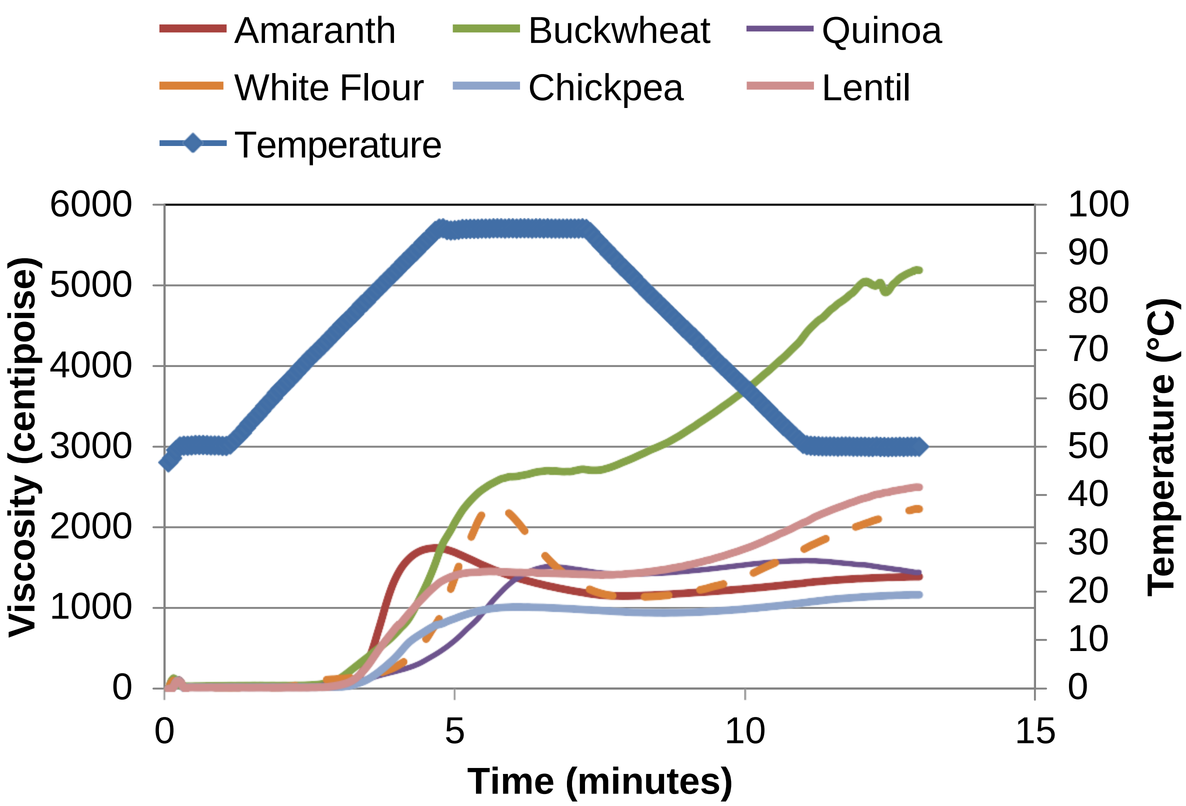
Legumes and pseudocereals have multiple functional properties such as water absorption, swelling, solubility, gelatinisation, pasting, and oil absorption which are all important factors in numerous processing applications. However, the processing of legumes and pseudocereals is very important as they contain substances which inhibit the digestion process, negatively influence the biological utilisation of nutrients, and interfere with metabolic pathways.

POTENTIAL

We can gain valuable insights into the potential applications of legume and pseudocereal flour by evaluating the starch properties along with polymer interactions, functional characteristics around water binding capability, solubility, viscosity, gelling and foaming properties as well as emulsifying capability

Three pseudocereals (amaranth, buckwheat and quinoa) and two pulses (lentil and chickpea) were tested.

Figure 1 – RVA results of selected legumes and pseudocereal flours against soft white wheat flour.



IMPACT ON BAKING

The gelatinisation temperature of starch is important as it indicates the processing conditions required to cook the starch in order to set the structure. Table 1 shows that all of the alternative grains and pulses we tested begin to gelatinise at higher temperatures than the soft wheat white flour. Products containing significant amounts of these alternative flours will set later (higher temperature) when baked. Wheat gelatinises and finishes earlier than all the other flours we tested, further supporting the fact that higher processing temperatures are required when incorporating pseudocereals or pulses into products to enable the starch to set the structure. The temperature range of the gelatinisation process is also of interest as it influences the point at which product structure was fully set. The table below shows that quinoa is the closest to the control but lentil flour has a temperature range 8°C above this and if incorporated into a product could result in alterations to the baking process to achieve an optimum end product.

Table 1 - DSC gelatinisation properties of flours

	Gelatinisation temperature (°C)			**Temperature range of starch gelatinisation**	**Enthalpy of starch gelatinisation**
Flour	**Onset (°C)**	**Peak (°C)**	**End (°C)**	**°C**	**(J/g solids)**
Soft wheat white flour	57.7 ± 0.0	64.0 ± 0.1	70.7 ± 0.2	13.0	7.32 ± 0.60
Chickpea	66.8 ± 0.1	75.6 ± 0.0	84.1± 0.0	17.3	3.80 ± 0.23
Lentil	61.9 ± 0.1	70.5 ± 0.1	83.9 ± 0.1	22.0	6.26 ± 0.17
Quinoa	66.5 ± 0.3	72.6 ± 0.3	80.5 ± 0.3	14.0	4.65 ± 0.33
Buckwheat	64.5 ± 0.1	72.2 ± 0.2	81.8 ± 0.2	17.5	6.29 ± 0.64
Amaranth	71.9 ± 0.1	78.2 ± 0.1	88.5 ± 0.3	16.6	6.59 ± 0.11

APPLICATIONS

Overall the RVA profile of buckwheat is similar to that of rice and maize flour, both of which have some commercial success in gluten free applications. Amaranth flour could have possible applications in high shear systems as a replacement for modified cross linked starches. Quinoa could offer good potential for process control when utilised in an end use. The low breakdown values for quinoa and buckwheat suggest it may have good freeze thaw capabilities. Of the legume flours we tested, chickpea flour gave low viscosity when compared with the lentil flour. This suggests that chickpea flour could be included in some formulations without causing adverse changes to the rheological properties of the mix.

AN ALTERNATIVE TO CEREALS?

The results indicate that different grain and pulse types will have an impact on the functional properties and the baking behaviour of the flour. It’s therefore important if you are considering using a blend of alternative flours and wheat flour in a product, or completely replacing wheat flour in a recipe, to consider how the starch will behave when incorporated into a product.

At Campden BRI we can offer support such as pilot scale milling of grains and pulses as well as functional and compositional analyses of ingredient and final products, consultation and trouble-shooting.