PHYSICAL AND CHEMICAL EFFECTS OF BRAN ON BROWN BREAD

by

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I declare that the thesis herewith submitted for the PhD (Food Science) degree at the University of Pretoria, had not been previously submitted by me for a degree at any other University

ABSTRACT

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Brown bread was produced by adding three bran fractions of different sizes (Pollard < 0.75 mm diam., Select > 0.75 mm < 1.8 mm and Digestive > 1.8 mm), from the same grist, to a common base white flour. The addition of bran caused loaf volumes to be depressed and crumb structures to be coarse. Bran components appeared to affect gluten functionality by changing its physicochemical characteristics through a subtle interplay of chemical and physical effects.

Pollard depressed loaf volumes the most, and Digestive bran the least. This could probably be attributed to differences in chemical composition. Pollard had the highest fat content, and therefore probably the highest lipoxygenase and glutathione concentrations, which adversely affected loaf volume. Subjecting the brans to a dry heat-treatment, which inactivated lipase and reduced the total reducing substances of which glutathione is part, increased loaf volume. This suggests that a chemical effect of the bran (probably the lipid metabolising enzymes lipase and lipoxygenase, as well as glutathione) is at least in part responsible for loaf volume depression. Heat treatment had the greatest effect on decreasing loaf volume depression in breads baked with Pollard and the least on breads Baked with Digestive bran, indicating a greater chemical effect in brans with smaller particle size.

A similar baking study was conducted with bran from 10 widely differing wheat samples (all of the same nominal particle size range). The different brans caused different levels of loaf volume depression. In all cases, dry heat-treatment of the brans decreased total reducing substances, inactivated lipase and increased loaf volume and height. However, the loaves still differed somewhat in volume. It is possible that differences in chemical composition of the different bran sources also accounted for these differences in loaf volume depression.

In addition to the difference in chemical compositions of the different brans, the higher loaf volumes of breads baked with Digestive bran, compared to those baked with Pollard, could also possibly be explained by the large, flaky Digestive bran particles trapping air bubbles in the dough. These air bubbles possibly provided extra nucleation sites for gas cells, as well as oxygen, which improved oxidation of the gluten and functioning of the oxidising agent ascorbic acid. The theory that Digestive bran particles trap air, could also probably explain why at low levels of addition, breads baked with Digestive bran had higher loaf volumes than the white bread controls. However, for large bran particles to be able to increase loaf volume, they have to be free of epicarp hairs.

Heat treatment did not result in all the brans producing loaves of the same volume, suggesting that a physical effect of the bran is also responsible for loaf volume depression. CAT scanning of proofing dough showed a uniform crumb structure in white bread dough in contrast with bubbles in brown bread dough, which were large and irregular. Bubbles became more elongated as proofing progressed. Bran probably ruptured the gas cell walls of the foam structure, leading to coalescence of the bubbles. Coalescence caused larger and irregular bubbles with lower internal pressures, probably resulting in lower loaf volumes.

It is concluded that there is a subtle interplay between the chemical and physical effects of bran on brown bread, which determines the extent of loaf volume depression. The addition of either large, epicarp hair free bran particles, or heat-treated smaller bran particles to white base flour are potential methods of optimising brown bread loaf size.

UITTREKSEL

FISIESE EN CHEMIESE EFFEKTE VAN SEMELS OP BRUINBROOD

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Bruinbrood is vervaardig deur die byvoeging van drie semelfraksies vanaf dieselfde maalkoring met verskillende groottes (Pollard < 0.75 mm diam., Select > 0.75 mm < 1.8 mm en Digestive > 1.8 mm), tot 'n basis witmeel. Die byvoeging van semels het laer broodvolumes en 'n growwe tekstuur tot gevolg gehad. Dit blyk dat semelkomponente die glutenfunksionaliteit beinvloed het deur 'n subtiele wisselwerking tussen chemiese en fisiese effekte.

Pollard het broodvolume die meeste onderdruk, en Digestive semels die minste. Dit kan moontlik toegeskryf word aan verskille in chemiese samestelling. Pollard het die hoogste vetinhoud gehad, en daarom moontlik ook die hoogste lipoksigenase en glutatioon konsentrasies, wat die broodvolume nadelig beinvloed het. Deur die semels aan 'n droë hittebehandeling bloot te stel, wat lipase geinaktiveer het en totale reduserende stowwe, waarvan glutatioon deel is, verminder het, is broodvolumes verhoog. Dit dui daarop dat 'n chemiese effek van die semels (waarskynlik die vetmetaboliserende ensieme lipase en lipoksigenase, sowel as glutatioon) ten minste gedeeltlik verantwoordelik is vir broodvolume onderdrukking. Hittebehandeling, om broodvolume te onderdruk, het die grootste effek gehad in brode gebak met Pollard, en die minste in brode met Digestive semels, wat 'n groter chemiese effect in semels met kleiner partikelgrootte aandui.

'n Soortgelyke bakstudie is gedoen met semels van 10 verskillende koringmonsters (almal met dieselfde nominale partikelgrootte reeks). Die verskillende semels het verskillende vlakke van broodvolume onderdrukking tot gevolg gehad. Droë hittebehandeling van die semels het totale reduserende stowwe in all gevale verminder, lipase geinaktiveer en broodvolumes and hoogtes verhoog. Tog het die broodvolumes nog ietwat verskil. Dit is moontlik dat verskille in chemiese samestelling van die verskillende semelbronne ook vir hierdie verskille in broodvolume onderdrukking verantwoordelik gehou kan word.

Bo en behalwe die verskille in chemiese samestellings van die verskillende semels, kan die hoër broodvolumes van brode gebak met Digestive semels, in vergelyking met die wat gebak is met Pollard, ook moontlik verklaar word deur die groot, vlokkige Digestive semelpartikels wat lugborrels in die deeg vasgevang het. Hierdie lugborrels kon moontlik ekstra nukleasie plekke vir gasselle verskaf het, sowel as suurstof, wat oksidasie van die gluten en werking van die oksideermiddel askorbiensuur verbeter het. Die teorie dat Digestive semelpartikels lug vasvang, kan moontlik ook verklaar waarom, teen lae byvoeginsvlakke, brode gebak met Digestive semels hoër volumes gehad het as die witbroodkontroles. Groot semelpartikels sal egter net in staat wees om broodvolumes te verhoog indien dit geen epikarphare bevat nie.

Hittebehandeling het nie veroorsaak dat al die semels brode met dieselfde volumes geproduseer het nie, wat aandui dat 'n fisiese effek van die semels ook verantwoordelik is vir broodvolume onderdrukking. CAT skandering van rysende deeg het 'n univorme tekstuur in die witbrooddeeg gewys, in kontras met gate in bruinbrooddeeg wat groot en onreëlmatig was. Gate het meer verleng geraak soos wat rysing verloop het. Semels het waarskynlik gasselwande van die skuimstruktuur gebreek, wat tot samesmelting van die gate gelei het. Samesmelting het groter and onreëlmatige gate met laer interne druk veroorsaak, wat waarskynlik laer broodvolumes tot gevolg gehad het.

Dit kan afgelei word dat daar 'n subtiele wisselwerking tussen die chemiese en fisiese effekte van semels op bruibrood is, wat die mate van broodvolume onderdrukking bepaal. Die byvoeging van of groot, epikarhaarvry semelpartikels, of hittebehandelde kleiner semelpartikels tot witmeel, is moontlike metodes om bruinbroodgrootte te optimiseer.

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INTERESTING FACTS ABOUT BREAD....

1. More than 98% of convicted felons eat bread.
2. Half of all children in bread-consuming households score below average on standardised tests.
3. More than 90% of violent crimes are committed within 24 hours of eating bread.
4. Primitive tribal societies that have no bread exhibit a low incidence of cancer, Alzheimer's and Parkinson's disease, as well as osteoporosis.
5. Bread has been proven to be addictive. Subjects deprived of bread and given only water, begged for bread after as little as two days.
6. Newborn babies can choke on bread.
7. Bread is baked at temperatures as high as 230°C. This heat can kill an adult in less than one minute.
8. Most bread eaters are utterly unable to distinguish between significant scientific facts and meaningless statistical babbling!

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