# ANCIENT WHEATS: POTENTIAL FOR FOOD PROCESSING

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Wheat is among the oldest and most extensively grown of all crops in the world. It is accepted that wheat was first grown as a food crop about 10000-8000 BC. Einkom and/or emmer wheat are generally considered to be related ancestors of modem species. Ancient wheats can be simply defined as the oldest or earliest cultivated wheats by mankind such as emmer and einkom or forgotten wheats such as spelt. Of these ancient wheats, spelt and einkom are currently of interest to researchers, processors and consumers. Most of the interest in these wheats arises from the claims that einkom and spelt proteins are not toxic for people having gluten intolerance, allergenicity or coeliac disease. Therefore, some of these wheats are being grown to provide organic alternative wheats which could be used in producing specialty bakery products, organic and health foods. For example, spelt wheat is already being used in producing specialty baked goods in Canada. Also, spelt wheat is reported to have a unique flavor and to be more nutritious. On the other hand, ancient wheats show poor quality in conventional breadmaking. Doughs prepared from einkom flour exhibited lower mixograph characteristics and were sticky, difficult to handle, and produced low bread loaf volumes. Also, spelt wheat produced bread with poor quality relative to that prepared from the common wheat cultivar Katepwa. In the present investigation, a diverse range of breakfast, bread and pasta products were processed from ancient wheats in order to evaluate their potentials for the food processing industry. Also, trials were conducted in order to improve the quality of the food products made from ancient wheats.

**Flaked Breakfast Food**

Spring spelt (hard-grained, large seeded, white- hulled spelt) SK0021accession (spelt 1) and PGR8801 accession (spelt 2) and soft-grained einkom TM23, which previously showed poor quality and functionality in breadmaking, were evaluated for producing wheat flakes as'breakfast cereals using a drum drying process. Wheat grains were milled into flours, then partially cooked and processed into flakes on a double drum dryer. The flour yields of einkom and spelt wheats exceeded that of common wheat by about 4-5%, but additional sifting was required in milling of both hard and soft endosperm ancient wheats to separate the branny material from flour (Table 1).

The effect of drum drying on the nutrients in flaked product was also evaluated (Table 1). Drum drying had slight effects on protein, ash and digestible carbohydrate, but fat and total dietary fiber (TDF) were markedly influenced. Fat content decreased by about 50, 46 and 54% in einkom, spelt and common wheat flakes, respectively. But, TDF apparently increased by about **21%** in the four types of wheat flakes. Ancient wheats were better able to resist the effects of heating during the process as compared with common wheat.

Generally, einkom and spelt produced acceptable breakfast flakes based on a g-point hedonic scale (Table 1). There were no significant differences in product color among the ancient and common wheats. But, a slight increase in color scores was observed in einkom and spelt flakes. However, the product flavor of spelt flakes were rated higher than those of einkom and common wheat flakes. This finding confirms that spelt may have a unique flavor as reported by Jacquot et al (1960). The panelists liked the flavor of spelt flakes, scoring 7.7 on the g-point scale, while einkom and common wheat flakes scored only 6.3 and 6.7, respectively. Furthermore, spelt flakes

were superior in texture compared to other wheat flakes. Spelt flakes were crispy, easy to break and exhibited a firm texture when served with milk. In general, hard spelts appear to have potential in the production of flaked breakfast foods having unique flavor and texture without addition of taste and/or texture improvers. It is likely that an extrusion process could produce spelt breakfast flakes of superior quality to those produced by the drum drying process.

***Table 1. Properties of einkom, hard spelt and common wheat grain, flour andjlaked breakfast products***

| Property | Einkom | Spelt 1 | Spelt 2 | HRS Katepwa |
|---|---|---|---|---|
| Kernel and milling properties | | | | |
| Kernel Wt (mg) | 32.2 | 39.0 | 41.1 | 33.2 |
| Hardness (sec) | 64 | 26 | 28 | 26 |
| Flour yield (%) | 76.0 | 77.8 | 77.2 | 72.1 |
| Chemical composition of flour (% dry basis) | | | | |
| Protein ( N x 5.7) | 18.1 | 17.6 | 17.3 | 16.2 |
| Fat | 2.0 | 1.5 | 1.7 | 1.3 |
| Ash | 0.8 | 0.7 | 0.7 | 0.6 |
| Total dietary fibre | 4.6 | 4.4 | 4.3 | 4.0 |
| Digestible carbohydrate[b] | 74.5 | 75.8 | 76.0 | 77.9 |
| Chemical composition of wheat flakes (% dry basis) | | | | |
| Protein (N x 5.7) | 17.8 | 17.5 | 17.2 | 15.6 |
| Fat | 1.0 | 0.9 | 0.8 | 0.6 |
| Ash | 0.9 | 0.8 | 0.7 | 0.5 |
| Total dietary fibre | 5.8 | 5.7 | 5.5 | 5.0 |
| Digestible carbohydrate[b] | 74.5 | 75.1 | 75.8 | 78.3 |
| Taste panel score[c] of flakes | | | | |
| Color | 7.0a | 6.8a | 6.9a | 6.5a |
| Flavor | 6.3b | 7.6a | 7.7a | 6.7b |
| Texture | 6.2b | 7.7a | 7.7a | 6.6b |

High values indicate soft endosperm texture.
[b]By difference.
"Nine point hedonic scale, l=dislike extremely and 9=like extremely.
[d]Means in a row with the same letters are not significantly different at $p < 0.05$ and n=11.

**Flat** bread

Ancient wheats from soft-grained black-hulled spelt were evaluated for producing an ancient bread (flat bread), known in Canada as pita bread. This type of bread requires wheats with medium gluten strength because the flat loaf has a small quantity of crumb and higher crust to crumb ratio than pan bread. Therefore, soft spelts SK0263 accession (spelt 3) and RL5407 accession (spelt 4), which showed strong gluten strength comparing to einkom and hard spelts, or medium gluten strength as compared with common wheat, were evaluated in making flat bread. A representative sample of spelt and common wheats from 1992 and 1993 crops were milled into flours with average yields of about 74% and 71% respectively (Table 2). Again, spelt wheats gave higher flour yields than common wheat, but additional sifting was required. The flours were baked into flat breads as described elsewhere (Abdel-Aal et al 1993).

The chemical compositions of soft spelt flours and their pita bread products are presented in Table 2. Protein contents of pita breads increased from 14.3% (in flours) to 15.5% due to the addition of yeast in the baking formula However, fat content decreased by about 57% as a result of using high temperature (325") in the baking process. The ash content of flours and breads averaged 0.8 and 2.0% respectively. Pita breads contained more than double the ash relative to their corresponding flours due to the addition of salt in the baking formula. Total dietary fiber content was slightly higher in common wheat flours as compared with spelt flours. Flat breads had higher concentrations of TDF comparing to their corresponding flours. The average TDF contents were 4.0 and 4.4% in spelt and common wheat flat breads, respectively. Digestible carbohydrate (starch and soluble sugars) was lower in flat breads relative to their original flours due to increases in protein, ash and TDF.

Spelt and common wheat breads were also evaluated on a g-point hedonic scale based on crust and crumb color, flavor, texture and layer separation or degree of puffing (Table 2). Based on crust and crumb colors, common wheat was rated higher than spelt. Addition of dry skim milk or whey proteins could improve both crust and crumb colors. Also, modification of baking time and/or temperature can be used to control crust and crumb colors. There was no significant difference between spelt and common wheat bread in flavor and all the breads rated as moderately acceptable with an average score of 6.8 $\pm 0.2$. In flat bread, yeast is a major factor in flavor development. Spelt flat breads possessed textural characteristics quite similar to those of common wheat flat breads. Spelt and common wheat produced flat breads having good layer separation or puffing degree which is preferred in this type of bread. Based on the present results soft spelts can be used in pita bread production without further improvement. However, in the case of pan bread production, further adjustment in the spelt baking formula are necessary. Preliminary experiments using some natural dough improvers have given promising results. The improved spelt pan bread had loaf volume of about 800 to 900 cc which is as high as top quality common wheat pan breads.

Table 2. ***Properties of soft spelt and common wheat grain, flour and flat bread products***

| Property | Spelt 3 | Spelt 4 | HRS Katepwa |
|---|---|---|---|
| Kernel and milling properties | | | |
| Kernel Wt (mg) | 41.5 | 41.7 | 34.1 |
| Hardness (sec) | 41 | 41 | 27 |
| Flour yield (%) | 75.2 | 73.5 | 71.0 |
| Chemical composition of flour (% dry basis) | | | |
| Protein ( N x 5.7) | 13.9 | 14.3 | 14.8 |
| Fat | 1.7 | 1.8 | 1.3 |
| Ash | 0.8 | 0.9 | 0.7 |
| Total dietary fibre | 3.2 | 3.2 | 3.5 |
| Digestible carbohydrate | 80.4 | 79.8 | 79.7 |
| Chemical composition of flat bread (% dry basis) | | | |
| Protein (N x 5.7) | 15.2 | 15.5 | 16.0 |
| Fat | 0.7 | 0.8 | 0.6 |
| Ash | 2.0 | 2.0 | 1.9 |
| Total dietary fibre | 4.0 | 4.0 | 4.4 |
| Digestible carbohydrate[b] | 78.1 | 77.7 | 77.1 |
| Taste panel score[c] of flat bread | | | |
| Crust color | 6.2b | 6.4b | 7.3a |
| Crumb color | 6.2b | 5.8b | 7.2a |
| Flavor | 6.7a | 6.7a | 6.9a |
| Texture | 6.9a | 6.5a | 7.1a |
| Layer separation | 7.5a | 7.4a | 7.5a |

"High values indicate soft endosperm texture.
[b]By difference.
"Nine point hedonic scale, l=dislike extremely and 9=like extremely.
[d]Means in a row with the same letters are not significantly different at $p < 0.05$ and n=l **1.**

**Pasta product**

Hard-grained spring spelt PGR8801 (spelt 2) and Kamut wheat (a large-seeded hard-grained durum relative) were milled into semolina in order to measure their use in pasta processing relative to the durum cultivar, Kyle. Kamut wheat produced semolina similar to durum

based on yield and color, while spelt had a lower semolina yield and a lower yellow color value (+ b) (Table 3). Spelt semolina was desirably low in water absorption and lipoxygenase. Kamut semolina absorbed more water and had the highest lipoxygenase activity. High lipoxygenase activity is not a desired property in semolina due to partial pigment loss during pasta processing. Processing and cooking of pasta had little effect on the chemical composition of products, except for some losses of digestible carbohydrates which apparently increased the dietary fibre. Cooking loss of the pasta products made from the three wheats was similar, averaging only 3.3%. This finding indicates that kamut and spelt have suitable quality in pasta processing. Also, the three wheat pasta products had similar textural properties. The pasta products were also evaluated by a sensory test using 4-point scale. In general, all the pasta products were acceptable. Kamut pasta was very similar to durum pasta based on color, flavor and textural properties, but spelt pasta was poor in color and appearance. The use of a natural yellow coloring agent or pigment could improve the appearance of cooked spelt pasta. Based on the current results, it appears that Kamut has considerable potential for making pasta products. In such a case, identification of a low lipoxygenase activity strain is desirable.

Table 3. ***Properties of hard spelt, kamut and durum grain, semolina*** and ***pasta products***

| Property | Spelt 2 | Kamut | Durum, Kyle |
|---|---|---|---|
| Kernel and milling properties | | | |
| Kernel Wt (mg) | 41.1 | 69.6 | 46.1 |
| Hardness (sec)[a] | 28 | 15 | 15 |
| Semolina yield (%) | 41.5 | 53.8 | 53.7 |
| Flour yield (%) | 41.2 | 24.7 | 24.2 |
| Shorts (%) | 7.7 | 15.0 | 13.8 |
| Bran (%) | 9.9 | 6.6 | 8.4 |
| Characteristics of semolina | | | |
| Color | | | |
| L (100 white, 0 black) | 79.2 | 78.3 | 79.6 |
| a (+ red, - green) | ***2.1*** | ***2.2*** | 1.6 |
| b (+ yellow, - blue) | ***12.5*** | 19.0 | 19.1 |
| Total color difference (AE) | 18.1 | 23.3 | 22.2 |
| Water absorption (%) | 59.1 | 71.6 | 68.6 |
| Lipoxygenase activity ($\mu$moles of dienes.min$^{-1}$.g$^{-1}$) | 148.4 | 194.0 | 134.4 |
| Chemical composition of semolina (% dry basis) | | | |
| Protein ( N x 5.7) | 14.4 | 12.0 | 11.8 |

*Table 3. Continued*

| | | | |
|---|---|---|---|
| Fat | 1.9 | 1.2 | 1.5 |
| Ash | 1.1 | 1.2 | 1.1 |
| Total dietary fibre | 5.6 | 5.8 | 5.2 |
| Digestible carbohydrate[b] | 77.3 | 79.8 | 80.5 |
| Chemical composition of cooked pasta (% dry basis) | | | |
| Protein (N x 5.7) | 14.6 | 12.3 | 12.0 |
| Fat | 1.6 | 1.1 | 1.4 |
| Ash | 1.2 | 1.3 | 1.1 |
| Total dietary fibre | 6.8 | 7.0 | 6.6 |
| Digestible carbohydrate[b] | 75.8 | 78.3 | 78.9 |
| Characteristics of cooked pasta | | | |
| Cooking loss (%) | 3.2 | 3.3 | 3.3 |
| Stickiness (g) | 43.0 | 41.5 | 43.5 |
| Firmness (max. force, g) | 65.0 | 66.5 | 66.5 |
| Firmness (work, g.cm) | 8.8 | 9.3 | 8.4 |
| Taste panel score ‘of cooked pasta | | | |
| Appearance | 2.4b | 3.5a | 3.8a |
| Color | 1.9b | 3.7a | 4.0a |
| Flavor | 2.7b | 3.3a | 3.6a |
| Stickiness | 3.2a | 3.2a | 3.4a |
| Firmness | 3.2a | 3.4a | 3.4a |

“High values indicate soft endosperm texture.
[b]By difference.
“Four point scale, 4=good, 3=fair, 2=poor and 1=very poor.
[d]Means in a row with the same letters are not significantly different at p 0.05 and n=ll.

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## REFERENCES

Abdel-Aal, E-S.M., Sosulski, F.W., Youssef, M.M. and Shehata, A.Y. 1993. Selected nutritional, physical and sensory characteristics of pan and flat breads prepared from composite flours containing fababean. Plant Foods for Human Nutrition 44: 227-239.

Jacquot, R., Adrian, J. and Rerat, A. 1960. A forgotten cereal species: Spelt or Dinkel (*Triticum* spelta). Z. Acker Pflanzenbau. 3: 279-288.