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Effect of Flour Fractionation on Functional Properties, Antioxidant Capacity, and Phenolic Acids in Wheat Flour

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INTRODUCTION & AIM

Bread is a widely consumed staple food, and whole wheat products offer health benefits due to their dietary fibre and antioxidants[1]. However, whole wheat bread consumption remains low in the UK[2], presumably due to dense texture, low loaf volume, and darker colour caused by bran interference with gluten formation. While flour fractionation is commonly used to improve bread quality, its effect on bioactive compounds and antioxidant activity remains underexplored. This study investigates how controlled flour sieving at 250 µm and 500 µm influences bread colour, water absorption, phenolic and flavonoid content, and antioxidant capacity, linking particle size to both functional and nutritional quality.

METHOD

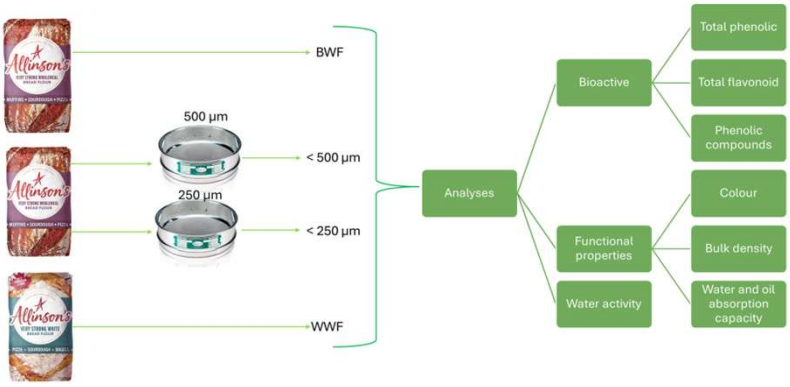

Fig. 1: Flour types (whole wheat, white, and fractionated) and the analyses conducted on each fraction.

Table 1: Selected functionality and water activity of wheat flours

Flour type	WAC (%)	OAC (%)	LBD	PBD	aw
WWF	71.20 ±1.09^{b}	72.80 ±2.94^{a}	0.54 ±0.01^{a}	0.77 ±0.01^{ab}	0.49 ±0.01^{b}
BWF	82.37 ±3.28^{a}	63.18 ±1.83^{b}	0.52 ±0.01^{b}	0.76 ±0.02^{a}	0.46 ±0.02^{c}
<500 µm	65.20 ±6.01^{c}	59.60 ±2.88^{c}	0.53 ±0.01^{ab}	0.78 ±0.01^{a}	0.49 ±0.01^{b}
<250 µm	68.80 ±2.38^{c}	76.00 ±2.34^{a}	0.52 ±0.01^{b}	0.77 ±0.01^{ab}	0.57 ±0.01^{a}

Values are reported as Mean ± Standard deviation. Mean with different superscript are significantly different (P ≤ 0.05). WAC: Water absorption capacity; OAC: Oil absorption capacity; LBD: Loose bulk density; PBD: Packed bulk density; aw: Water activity; Whole white wheat flour (WWF); whole brown wheat flour (BWF); <500 µm: Flour sieved through a sieve of 500 µm aperture; <250 µm: Flour sieved through a sieve of 200 µm aperture

Table 2: Selected Bioactive compounds and antioxidant assays analysed in fractionated wheat flours

Flour type	TPC (mg GAE/g)	TFC (mg QE/g)	ABTS (% inhibition)	DPPH
WWF	1.39 ±0.74^{c}	1.31 ±0.19^{b}	19.97 ±0.77^{b}	87.74 ±0.11^{c}
BWF	3.26 ±0.46^{a}	1.76 ±0.26^{a}	22.90 ±1.55^{a}	88.59 ±0.11^{a}
<500 µm	3.17 ±0.06^{a}	1.68 ±0.17^{a}	18.29 ±0.77^{c}	88.38 ±0.12^{b}
<250 µm	1.97 ±0.11^{b}	1.42 ±0.06^{b}	19.13 ±0.77^{bc}	87.53 ±0.20^{d}

Values are reported as Mean ± Standard deviation. Mean with different superscript are significantly different (P ≤ 0.05). TPC: Total phenolic content; TFC: Total flavonoid content; ABTS: 2,2'-Azino-bis(3-ethylbenzothiazoline-6-sulfonic acid), DPPH: 2,2-Diphenyl-1-picrylhydrazyl; Whole white wheat flour (WWF); whole brown wheat flour (BWF); <500 µm: Flour sieved through a sieve of 500 µm aperture; <250 µm: Flour sieved through a sieve of 200 µm aperture; GAE: Gallic Acid Equivalent; QE: Quercetin Equivalent

BWF showed significantly higher phenolic compounds than the other flours, followed by the 500 µm fraction (Data not shown). Phenolic compounds were positively correlated with antioxidant properties, highlighting their contribution to bioactive functionality.

RESULTS & DISCUSSION

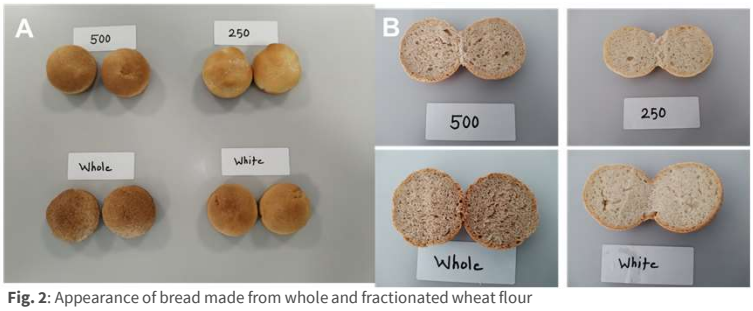

Fig. 2: Appearance of bread made from whole and fractionated wheat flour

A preliminary observation showed that flour fractionation influenced the bread's appearance and colour, resulting in noticeable differences in crumb structure and openness (Fig. 2). Bread made from whole wheat flour (WWF) was darker and had a more compact, denser crumb compared to bread made from break flour (BWF) and the fractionated flours, possibly due to the higher bran content in the flour.

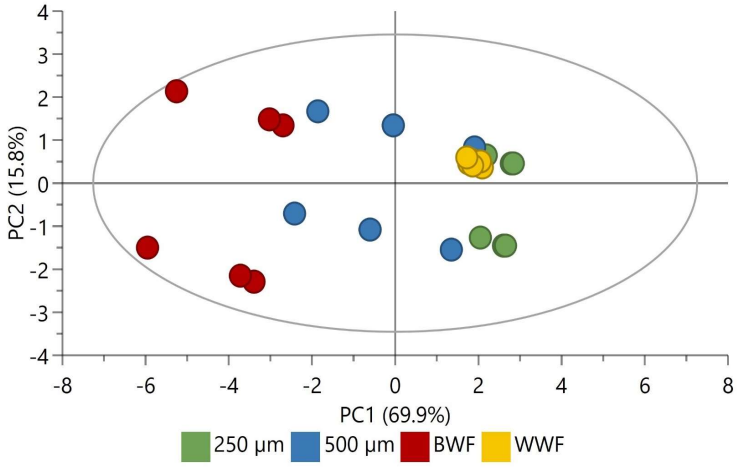

Fig. 3: Principal component analysis (PCA) of phenolic compounds from wheat flours. Whole white wheat flour (WWF) and whole brown wheat flour (BWF) <500 µm: Flour sieved through a sieve of 500 µm aperture; <250 µm: Flour sieved through a sieve of 200 µm aperture

PCA based on phenolic compound values separated the flour types according to their overall phenolic profiles. BWF samples were positioned on one side of PC1, indicating a distinct phenolic profile compared to WWF and fractionated flours (Fig. 3). The 500 µm fraction occupied an intermediate position, while the 250 µm fraction clustered near WWF, reflecting more similar phenolic profiles.

CONCLUSION AND FUTURE WORK

Targeted flour fractionation offers a promising way to improve the nutritional and functional quality of whole grain flours while maintaining bioactive compounds. Further work should test its use in various baked products.

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