

Nutritional and Quality Evaluation of Wheat Bread Enriched with Amaranth Sourdough

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INTRODUCTION & AIM

Amaranth (*Amaranthus spp.*), a gluten-free pseudocereal, is rich in protein and bioactive compounds (phenolic compounds, squalene, phytosterols, tocopherols, and dietary fiber), making it a valuable ingredient for improving the nutritional quality of baked goods. Incorporating amaranth flour into wheat bread, especially via sourdough fermentation, may enhance both nutritional and sensory properties.

This study aimed to evaluate the effects of amaranth sourdough addition at different substitution levels on the quality attributes and nutritional value of wheat bread prepared using two types of wheat flour.

Commercial **wheat flours of type 405 and 750** (GoodMills, Stradunia, Polska) were used, with a portion of the wheat flour substituted by **ground amaranth grain at levels of 5%, 10%, and 15%** in the **form of sourdough**. A control sample consisting of wheat bread without amaranth flour (0%) was also prepared.

METHOD

Amaranth seeds (GREEN ESSENCE, Pyrzyce, Poland) were ground using a KT-120 laboratory hammer type mill (Perten Instruments, Hägersten, Sweden) and amaranth flour was obtained. The granulation of flour was below 250 µm.

The research included the assessment of the quality parameters of amaranth flour and wheat flours, such as protein, ash content, and moisture, as well as gluten yield and spreadability, falling number, and Zeleny sedimentation index.

The amaranth sourdough was prepared using the LV1 starter culture (LESAFFRE) (0.5% relative to the flour weight), with a dough yield of 290, fermented at 30 °C for 20 hours. **Wheat bread** was baked with the single-stage (control bread) and two-phase method (with amaranth sourdough).

For the baked **breads, evaluations** included overbake, specific volume, crumb porosity (Dallman scale), crust and crumb color, texture profile analysis (TPA), organoleptic assessment, and nutritional analysis based on crumb moisture, protein, and total ash content. The average energy value and nutritional content per 100 g of flour blends used in baking (protein, lipids, carbohydrates, and fiber) were also calculated.

RESULTS & DISCUSSION

Table 1. The quality features and nutritional content of wheat bread enriched with amaranth sourdough depending on the wheat flour type and the share of amaranth flour

		Overbake [%]	Specific volume [cm³/g]	Crumb porosity [Dallman's scale]	Ash [g/100 g d.m.]	Total protein [g/100 g d.m.]	Crumb moisture [%]
Amaranth flour share [%]	0	50.3±1.2 a	3.8±0.0 b	3.7±0.6 a	0.9±0.0 b	12.1±0.6 d	46.3±1.3 a
	5	49.4±1.4 a	3.9±0.0 b	4.0±0.7 a	0.9±0.0 b	12.3±0.6 c	46.4±1.2 a
	10	48.6±1.4 a	4.0±0.0 ab	4.5±1.1 a	1.0±0.0 ab	12.4±0.8 b	45.9±1.6 a
	15	48.6±1.5 a	4.2±0.0 a	4.5±0.7 a	1.1±0.0 a	12.6±0.9 a	45.8±1.1 a
Wheat flour type	405	47.6±1.4 b	4.0±0.0 a	5.1±0.9 a	0.7±0.0 b	11.6±0.6 b	46.1±1.8 a
	750	50.9±1.7 a	4.0±0.0 a	3.2±0.6 b	1.2±0.1 a	13.1±0.8 a	46.2±1.4 a

Mean values marked with different letters in the same column within one factor indicate a statistical difference (a > b > c ... etc.) (p ≤ 0.05).

Table 2. Average nutritional values of bread depending on the type of wheat flour and the proportion of amaranth flour (according to the formulation)

		Energy value [kcal/100 g]	Protein [g/100 g of bread]	Fat [g/100 g of bread]	Carbohydrates [g/100 g of bread]	Dietary fiber [g/100 g of bread]
Amaranth flour share [%]	0	329±12 c	10.1±0.7 b	1.5±0.1 b	68.1±1.2 a	0.7±0.0 b
	5	333±13 b	11.9±0.6 a	2.2±0.2 a	62.4±1.4 b	3.2±0.1 a
	10	334±15 ab	10.9±0.2 a	1.4±0.1 d	65.3±1.7 b	1.6±0.1 c
	15	336±16 a	11.0±0.1 a	1.7±0.1 c	65.8±1.6 a	1.8±0.0 c
Wheat flour type	405	333±15 a	11.1±0.5 a	2.0±0.1 b	65.3±1.5 b	2.1±0.1 b
	750	334±14 a	11.2±0.9 a	2.3±0.2 a	64.8±1.2 c	2.3±0.2 a

Mean values marked with different letters in the same column within one factor indicate a statistical difference (a > b > c ... etc.) (p ≤ 0.05).

RESULTS & DISCUSSION

Table 3. The color parameters of the crust and crumb of wheat bread enriched with amaranth sourdough depending on the wheat flour type and the share of amaranth flour

		The crust color			The crumb color		
		L*	a*	b*	L*	a*	b*
Amaranth flour share [%]	0	46.2±1.4 a	11.4±1.2 a	20.9±1.5 a	67.8±1.3 a	-2.5±0.2 d	21.3±1.3 b
	5	41.2±1.3 b	9.4±1.1 b	13.8±1.3 c	66.1±1.1 b	-1.6±0.4 c	21.4±1.5 ab
	10	42.1±1.0 b	9.9±1.0 b	14.9±1.1 c	65.7±1.0 bc	-1.1±0.3 b	20.9±1.3 c
	15	45.9±1.5 a	9.8±0.8 b	18.7±1.4 b	65.3±1.4 c	-0.6±0.0 a	21.6±1.5 a
Wheat flour type	405	48.1±1.3 a	10.8±1.0 a	22.1±1.7 a	71.0±1.9 a	-2.9±0.3 b	22.7±1.6 a
	750	39.6±1.2 b	9.4±0.9 b	12.0±1.1 b	61.4±1.2 b	-0.1±0.0 a	19.9±1.2 b

Mean values marked with different letters in the same column within one factor indicate a statistical difference (a > b > c ... etc.) (p ≤ 0.05).

Table 4. The parameters of the Instrumental Test of Texture Profile Analysis (TPA) of wheat bread enriched with amaranth sourdough depending on the wheat flour type and the share of amaranth flour

		Hardness [N]	Cohesiveness	Springiness	Gumminess [N]	Chewiness [N*mm]
Amaranth flour share [%]	0	1.95±0.85 ab	0.81±0.02 a	0.96±0.02 b	1.57±0.15 ab	1.52±0.15 ab
	5	2.62±0.66 a	0.78±0.02 b	0.97±0.03 a	2.03±0.13 a	1.97±0.18 a
	10	1.90±0.45 ab	0.78±0.02 b	0.96±0.02 b	1.48±0.10 b	1.42±0.12 b
	15	1.72±0.44 b	0.77±0.02 b	0.96±0.02 b	1.30±0.11 b	1.24±0.11 b
Wheat flour type	405	2.04±0.76 a	0.81±0.01 a	0.96±0.02 a	1.64±0.12 a	1.59±0.15 a
	750	2.05±0.67 a	0.76±0.01 b	0.95±0.02 b	1.55±0.13 a	1.49±0.12 a

Mean values marked with different letters in the same column within one factor indicate a statistical difference (a > b > c ... etc.) (p ≤ 0.05).

Table 5. The organoleptic characteristics of wheat bread enriched with amaranth sourdough depending on the wheat flour type and the share of amaranth flour

		Appearance	Crust color	Crumb color	Texture	Aroma	Taste
Amaranth flour share [%]	0	7.6±0.3 a	7.9±0.3 a	7.7±0.3 a	7.5±0.3 a	7.8±0.3 a	7.6±0.3 a
	5	7.8±0.4 a	7.8±0.3 a	7.8±0.3 a	7.4±0.2 a	7.1±0.2 ab	6.7±0.2 b
	10	7.9±0.5 a	8.0±0.4 a	7.8±0.4 a	7.1±0.2 a	6.8±0.1 b	6.1±0.1 b
	15	7.7±0.5 a	7.7±0.4 a	7.6±0.3 a	7.4±0.2 a	6.4±0.1 b	6.2±0.3 b
Wheat flour type	405	7.7±0.5 a	7.9±0.4 a	7.7±0.2 a	7.3±0.2 a	6.8±0.1 a	6.3±0.2 b
	750	7.8±0.4 a	7.7±0.5 a	7.7±0.2 a	7.5±0.03 a	7.2±0.2 a	6.9±0.3 a

Mean values marked with different letters in the same column within one factor indicate a statistical difference (a > b > c ... etc.) (p ≤ 0.05).

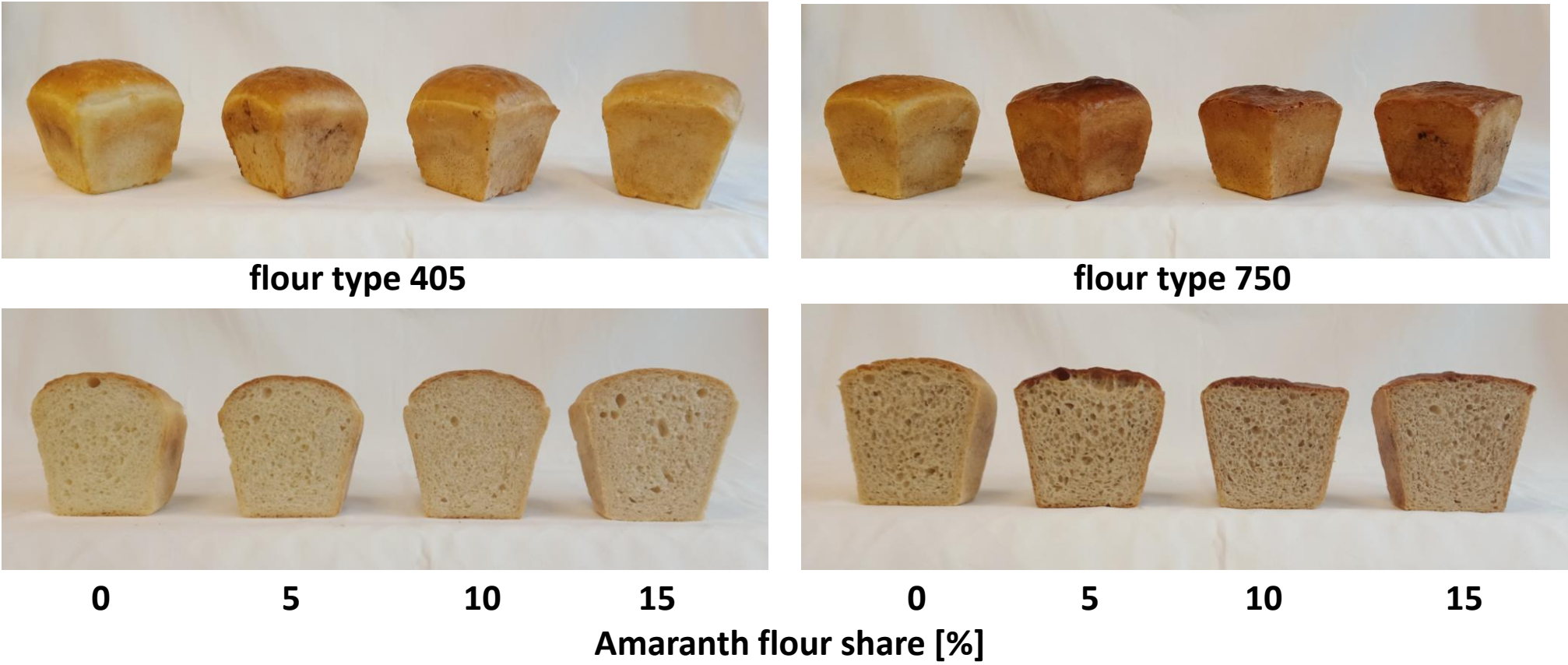


Figure 1. Images of whole breads and their cross-sections

CONCLUSION

The enrichment of wheat bread with amaranth sourdough positively influenced the quality parameters and nutritional profile of the final products, particularly in terms of protein and ash content. The addition of amaranth flour contributed to an increase in loaf volume. Bread containing 5% amaranth flour in the form of sourdough demonstrated improved hardness, springiness, gumminess, and chewiness compared to the control sample. **The maximum share should not exceed 10%.**

FUTURE WORK

Future research could investigate the use of amaranth sourdough with other functional ingredients, optimize fermentation conditions, and assess shelf life and consumer acceptability. Exploring its application in gluten-free or reduced-gluten bread could further expand its potential in health-oriented bakery products.