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The Impact of Chia Flour Incorporation on Wheat Dough Properties and Bread Quality

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INTRODUCTION & AIM

The incorporation of alternative ingredients in traditional wheat-based products has gained increasing interest due to their potential to enhance nutritional profiles and functional properties. **Chia flour**, derived from *Salvia hispanica* seeds, is recognized for its rich content of omega-3 fatty acids, fiber, and antioxidants.

The aim of the study was to assess the effect of different share (0/100, 5/95, 10/90, 15/85, 20/80 and 25/75 w/w ratios) of ground chia seed – chia flour (CF) on the rheological and **pasting properties** of blends obtained from two types (650 and 750) wheat flour (WF). Furthermore, the study focused on the evaluation of the **quality** and **nutritional attributes of wheat breads** (WB), emphasizing the utilization of two distinct dough preparation methods: single-phase (1F) and two-phase (2F).

METHOD

Chia seeds (TAR-GROCH-FIL, Zakliczyn, Poland) were ground using a laboratory mill type WŻ-1 (Sadkiewicz Instruments, Bydgoszcz, Poland) and chia flour (CF) was obtained. The granulation of CF was below 250 µm.

Blends were determined for total protein content – with the Kjeldahl method, Nx5.7. Properties of pastes made of the blends WF/CF were evaluated using an **amylograph** (Brabender, Duisburg, Germany). Mixolab 1 device (Chopin Technologies, Paris, France) was used to assess the wheat blends' rheological properties. **Wheat bread** (WB) was baked with the single-stage (1F) and two-phase (2F) method. In the both methods CF was used to prepare blends with WF in 0/100, 5/95, 10/90, 15/85, 20/80 and 25/75 ratios. The control sample was 100% WB. Each 24-hour-old bread sample was freeze-dried and subsequently milled with a laboratory mill WŻ1 (Sadkiewicz Instruments, Bydgoszcz, Poland).

After 24 hours, the **bread** underwent an **evaluation** based on specific volume (SA-WY bread volumeter (ZBPP, Bydgoszcz, Poland)), crumb porosity according to Dallmann's scale, as well as crust and crumb color (Minolta Colorimeter (CR-400/410, Konica Minolta, Japan)). Following the cooling process, the breads were weighed to determine overbake relative to the weight of the flour used in baking. Bread samples underwent consumer acceptance evaluation by a panel of ten participants. The assessment utilized a 9-point hedonic scale, ranging from 1 ("extremely dislike") to 9 ("like very much"). **Breads** were determined for: moisture, total protein content – with the Kjeldahl method (N×5.7) and total dietary fiber content (TDF). The samples were analyzed at least in duplicate, and the results are expressed on a dry matter (d.m.) basis.

RESULTS & DISCUSSION

Table 1. Amylographic features and total protein content of blends depending on flour type and chia flour share

		Initial gelatinization temp. [°C]	Final gelatinization temp. [°C]	Maximum viscosity [AU]	Total protein content [g/100 g d.m.]
Wheat flour type	650	53.2±0.4 a	84.6±0.6 a	1175±2.5 a	13.6±0.2 b
	750	53.7±0.3 a	85.0±0.9 a	540±1.3 b	14.0±0.3 a
Chia flour share [%]	0	57.3±0.6 a	82.4±0.7 a	655±1.8 a	12.8±0.1 e
	5	54.8±0.3 ab	84.9±0.5 a	903±1.9 a	13.2±0.3 de
	10	53.3±0.2 bc	85.2±0.6 a	945±1.7 a	13.5±0.1 cd
	15	53.3±0.6 bc	85.4±0.5 a	955±2.0 a	14.0±0.4 bc
	20	52.1±0.3 bc	86.0±0.7 a	898±1.9 a	14.3±0.3 b
	25	50.0±0.2 c	84.9±0.4 a	790±1.7 a	15.0±0.3 a

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

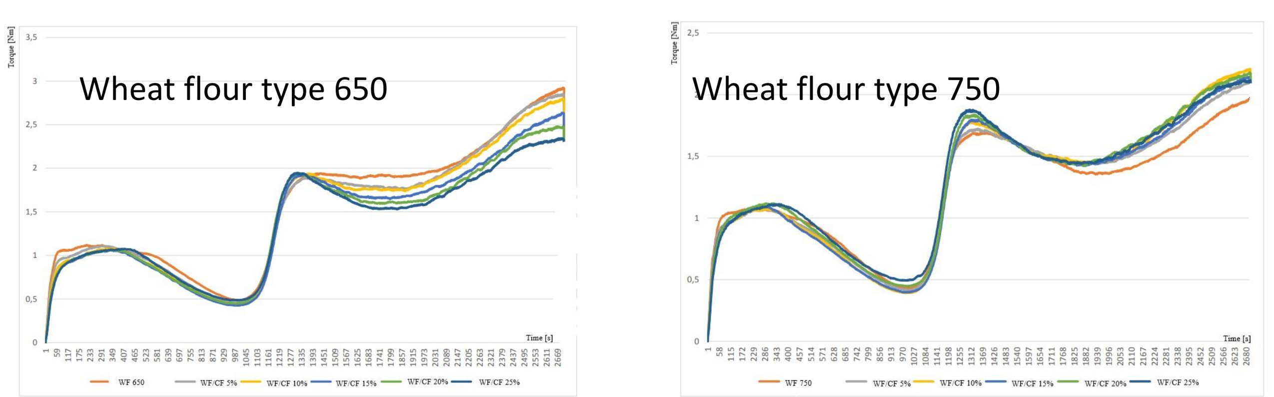

Figure 1. Mixolab diagrams for wheat flour type 650 and 750 with chia flour share

RESULTS & DISCUSSION

Table 2. The quality features and nutritional content of wheat bread enriched with CF depending on the WF type, the share of CF and baking method.

		Overbake [%]	Specific volume [cm^3/g]	Crumb porosity [Dallman's scale]	TDF [g/100 g d.m.]	Total protein [g/100 g d.m.]	Crumb moisture [%]
CF share [%]	0	52.5±1.2 c	3.69±0.07 ab	5.5±0.6 b	5.1±0.5 f	13.1±0.6 d	49.6±1.3 ab
	5	54.4±1.4 b	3.68±0.05 ab	6.5±0.7 a	6.7±0.6 e	13.4±0.6 c	47.5±1.2 bc
	10	54.3±1.4 b	3.73±0.06 a	7.0±1.1 a	8.6±0.9 d	13.6±0.8 c	50.6±1.6 a
	15	55.2±1.5 b	3.62±0.05 b	6.5±0.7 a	11.0±1.0 c	13.9±0.9 b	46.9±1.1 c
	20	59.6±1.9 a	3.57±0.05 bc	6.5±0.7 a	15.0±1.5 b	14.1±0.6 b	46.8±1.2 c
	25	58.8±1.8 a	3.46±0.04 c	6.5±0.7 a	17.4±1.7 a	14.4±0.5 a	47.2±1.3 bc
WF type	650	54.4±1.4 b	3.60±0.03 a	6.5±0.9 a	10.2±1.0 b	13.6±0.6 b	49.1±1.8 a
	750	57.2±1.7 a	3.62±0.06 a	6.0±0.6 b	11.1±1.1 a	13.9±0.8 a	47.1±1.4 b
Baking method	1F	55.3±1.5 b	3.66±0.04 a	6.5±0.7 a	10.8±1.1 a	13.6±1.3 b	49.0±2.4 a
	2F	56.3±1.6 a	3.56±0.05 b	6.5±0.7 a	10.5±1.0 a	13.9±1.4 a	47.2±2.1 b

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

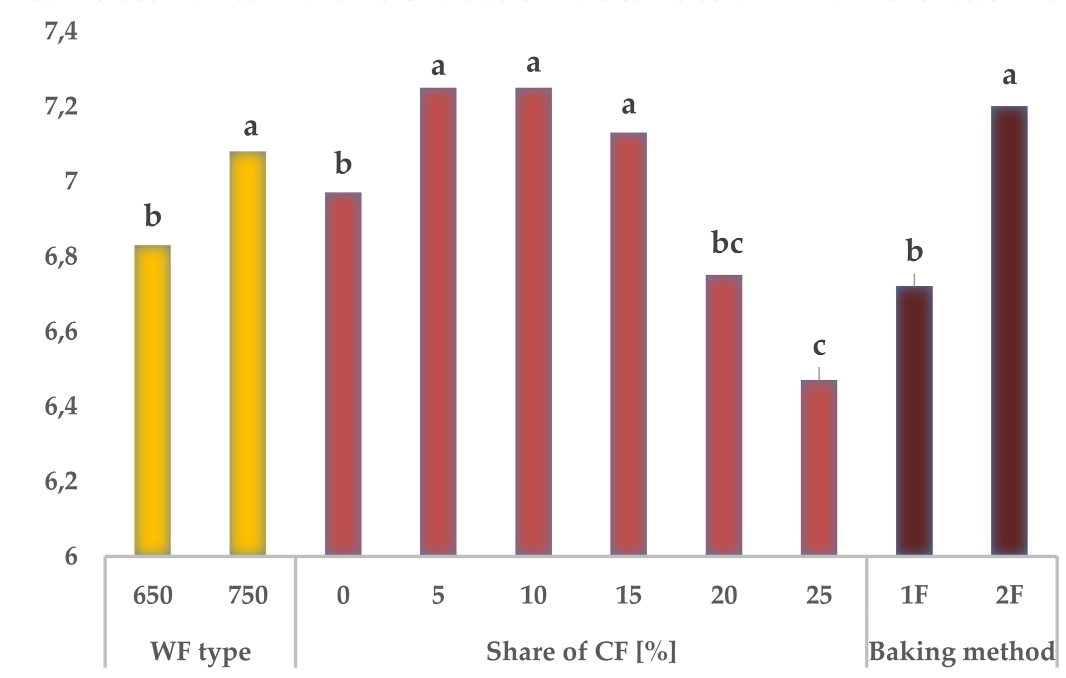

Figure 2. The consumer acceptance of WF/CF breads depending on the WF type, share of CF and baking method. Small letters in the same row within one factor indicate a statistical difference (a > b > c ... etc.) according to Duncan's test ($p \leq 0.05$).

Table 3. The color parameters of the crust and crumb of wheat bread enriched with CF depending on the WF type, the share of CF and baking method.

		The crust color			The crumb color		
		L*	a*	b*	L*	a*	b*
CF share [%]	0	45.2±1.4 a	10.9±1.2 a	14.8±1.5 a	57.4±1.3 a	2.4±0.2 f	13.5±1.3 a
	5	44.1±1.3 a	8.8±1.1 b	13.2±1.3 b	50.1±1.1 b	2.5±0.4 e	9.4±1.0 b
	10	41.3±1.0 b	7.5±1.0 c	11.2±1.1 c	47.6±1.1 c	2.8±0.6 d	8.1±0.9 c
	15	40.5±1.5 bc	6.7±0.8 cd	10.0±1.2 d	45.8±1.4 d	3.0±0.7 c	7.4±0.8 d
	20	39.0±0.9 c	6.4±0.8 d	8.9±1.0 e	44.2±1.2e	3.1±0.7 b	7.0±0.8 d
	25	35.7±0.7 d	5.8±0.7 d	7.0±0.8 f	41.8±1.1 f	3.3±0.8 a	6.6±0.5 e
WF type	650	42.2±2.3 a	7.5±0.9 a	11.7±1.1 a	49.4±1.1 a	2.7±0.3 b	8.9±1.1 a
	750	39.7±2.2 b	7.9±1.1 a	10.1±1.2 b	46.3±1.5 b	2.9±0.4 a	8.4±0.9 b
Baking method	1F	39.4±1.8 b	7.4±1.2 b	10.1±1.5 b	46.3±1.3 b	2.8±0.6 a	8.3±0.6 b
	2F	42.5±1.9 a	8.0±1.3 a	11.6±1.7 a	49.3±1.4 a	2.9±0.5 a	9.1±0.8 a

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

CONCLUSION

Current trends in healthier nutrient-dense foods show chia seeds and flour are becoming more popular to researchers because of their rich nutritional composition, and benefits to the human-health. As a result of the research, it was found that the optimal share of chia flour (CF) was 5-10 %. The share of CF up to 10 % did not result in deterioration of the quality of bread and consumer acceptance. Breads baked with wheat flour type 750 using the two-phase baking method were rated higher. The use of CF increases the nutritional value of bread products due to the content of proteins with the highest biological value, lipids with a high content of omega fatty acids and dietary fiber.

The addition of chia also inhibited the kinetics of amylopectin retrogradation during storage, which would be directly related to the delay in bread staling. The addition of chia flour has a positive effect on the technological and sensory value of bread products, therefore it is recommended to add it in amounts even greater than 10 %. Enhancing wheat bread with oilseeds possessing high antioxidant potential is a desirable alternative to recipe modification, offering improvements in both nutritional value and the quality of the resulting bread.

FUTURE WORK / REFERENCES

In order to eliminate the undesirable characteristics of chia seeds and flour, it would be worth considering using lactic fermentation to create an even more interesting and healthier addition to food in general, and not only to cereal products.