

THE EFFECT OF ADDED PUMPKIN FLOUR ON SENSORY AND TEXTURAL QUALITY OF RICE BREAD

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doi: [10.15414/jmbfs.2017.6.6.1269-1271](https://doi.org/10.15414/jmbfs.2017.6.6.1269-1271)

ARTICLE INFO

Received 16. 2. 2017
Revised 15. 3. 2017
Accepted 3. 5. 2017
Published 1. 6. 2017

Regular article



ABSTRACT

The impact of added pumpkin flour (1–10 g/100 g) on sensory and textural quality of rice bread was studied on rice biologically leavened rice bread. Specific volume, baking loss, crumb springiness, cohesiveness and resilience decreased with increasing amount of pumpkin flour. The opposite trend was found in crumb hardness and chewiness. Color measurements revealed that the lightness decreased and the greenness increased with increasing amount of pumpkin flour. Bread crumb and crust characteristics were not significantly impacted by the amount of added pumpkin flour. Additionally, the bread taste and flavor were decreased in breads with 8–10 g/100 g of added pumpkin flour, resulting in their lower overall acceptability. Weak impact of added pumpkin flour on sensory evaluation of rice bread may be related to a reduced amount of the panelists involved in this study. The addition of 1–7 g/100 g of pumpkin flour seems to be applicable to rice bread production. More extensive study will, however, be performed to describe the impact of added pumpkin flour on sensory quality of rice bread in more details.

Keywords: Gluten-free, fortification, crumb quality

INTRODUCTION

The nutritional quality of gluten-free (GF) breads is often decreased by low protein and fiber contents (Rosell *et al.*, 2001). It may be increased by the addition of nutritionally valuable ingredients. Pumpkin (*Cucurbita moschata*) flour is known to be rich in carotene, pectin, minerals, vitamins and other substances beneficial to health such as phenolic phytochemicals (Ptitchkina *et al.*, 1998; Kwon *et al.*, 2007; Dhiman *et al.*, 2009). Pumpkin has, moreover, potential to improve bland taste of rice bread due to its highly pleasure flavor and sweet taste. Additionally, pumpkin seeds proteins are known to increase in vitro protein digestibility of gluten free bread (El-Soukkary, 2001), which may also positively impact bread quality. Pumpkin flour is one of the processed products of pumpkin fruit, which can be easily stored for long time and conveniently used in manufacturing of formulated foods. Pumpkin flour could be used to supplement cereal flours in bakery products to improve nutritional, physical and sensory qualities of these products (Chi-Ho *et al.*, 2002; See *et al.*, 2007). The impact of pumpkin flour addition on nutritional quality of wheat bread was previously studied by See *et al.* (2007). They concluded that rising amount of pumpkin flour resulted in decrease of loaf specific volume but increase of crumb hardness. Moreover, increasing level of pumpkin flour resulted in decreasing sensory acceptability. The positive effect on loaf volume and organoleptic acceptability of bread were also reported by Ptitchkina *et al.* (1998). The effect on added pumpkin flour on quality of gluten free rice bread has, however, not been described yet. Thus, the aim of this study was to investigate the impact of added pumpkin flour on sensory quality of rice bread, crumb color, as well as crumb characteristics measured by texture profile analysis. Disregarding the reduced amount of panelists involved in this study, the obtained preliminary results may indicate an applicability of pumpkin flour in gluten-free breadmaking.

MATERIAL AND METHODS

Flours

Fine rice flour was kindly provided by Adveni Medical, spol. s r.o. Brno, Czech Republic.

Bread preparation

A formula for dough preparation consisted of rice flour (100 g), water (110 g), sucrose (1.86 g), salt (1.50 g) and yeast (1.80 g). The amounts of 1 g, 2 g, 3 g, 4 g, 5 g, 6 g, 7 g, 8 g, 9 g and 10.0 g of pumpkin flour were added on top of other ingredients. The amounts of the ingredients were related to 100 g of flour dry matter. Dry yeast was reactivated for 10 ± 1 min. in a sugar solution (35 ± 1 °C). The dough ingredients were placed into an Eta Exclusive Gratus mixer bowl (Eta, a.s. CZ) and mixed for 6 min. A 150 g of dough was scaled into bread pans and loaves were baked for 20 min. at 30 ± 1 °C and 85% relative air humidity. The loaves were baked for 20 min. at 180 ± 5 °C in an oven MIWE cube (Pekass s.r.o. Plzeň, CZ). After baking, the breads were stored at room temperature for 2 h, and then analyzed. Each test was performed on dough samples prepared at least in three replicates. The given results are represented as mean values.

Textural properties of bread

Textural properties of bread crumb were measured using texture profile analysis (TPA) on a texture analyzer TA.XT plus (Stable Micro Systems Ltd., UK). TPA was performed on samples 35 mm in diameter and 10 mm in height obtained from the center of each loaf. The sample was placed onto the analyzer base and squeezed twice to 4 mm with the 75.0 mm diameter cylinder probe P/75. Test speed of probe was 1.00 mm/s. The crumb parameters (hardness, stickiness, elasticity, cohesiveness and chewiness) were determined using Exponent Lite software.

Sensory evaluation

The breads were subjected to sensory evaluation by a panel of 10 department staff and students, both male and female between the ages of 19 - 50 years. A nine point hedonic scale was used to evaluate the characteristics of bread crumb and crust. Sensory score range from 1: dislike extremely to 9: like very much was used. An extensive sensory evaluation performed by higher number of panelists will be performed to support the preliminary results obtained in this study.

Statistical analysis

The results were statistically analyzed using analysis of variance (ANOVA). The differences were tested on $\alpha = 0.05$ significance level using Fisher LSD test. Statistical analysis was accomplished using Statistica CZ9.1 software (Stat Soft Ltd., CZ).

RESULTS AND DISCUSSION

Baking loss of rice bread (15 %) was decreased to 12 % by the presence of pumpkin flour (Table 1). The observation may be related to high pumpkin flour ability to absorb water during dough preparation as well as during baking (Rodge et al., 2012) decreasing the amount evaporated water. The bread baking loss

forms the biggest losses in the technological process. The value of baking loss of rice bread with pumpkin flour decreases compared with the control bread sample, therefore the technological bread weight losses during rice bread production using pumpkin flour could be not significant. According to the experimental results, the values of bread dry off are similar for the control and experimental bread samples.

Specific loaf volume of rice bread (1.17 g/mL) was decreased by the presence of pumpkin flour to 1.00–1.16 g/mL, however significant ($P < 0.05$) decrease was observed only in bread containing 4 g/100 g (1.00 g/mL), 5 g/100 g (1.01 g/mL), and 10 g/100 g (1.04 g/mL) of pumpkin flour (Table 1). The reduction can be explained by high content of fiber in pumpkin flour (Wang et al., 2004) since the fiber weakens dough structure, resulting in decrease of CO₂ retention in dough.

Table 1 The impact of added pumpkin flour on bread specific volume, baking loss and crumb characteristics evaluated by texture profile analysis

Pumpkin flour addition (g/100g)	Specific loaf volume (mL/g)	Baking loss (g/100g)	Hardness (N)	Springiness (%)	Cohesiveness (%)	Resilience (%)	Chewiness (N)
0	1.17±0.07 ^d	15±1 ^d	36±3 ^a	82±2 ^e	72±2 ^b	41±2 ^c	21±1.17 ^a
1	1.10±0.03 ^{bcd}	14±1 ^{cd}	43±7 ^{ab}	79±1 ^{de}	71±2 ^{ab}	40±2 ^{bc}	24±4 ^{abc}
2	1.10±0.03 ^{bcd}	12±1 ^{abc}	43±12 ^{ab}	75±3 ^{bcd}	71±4 ^{ab}	40±5 ^{abc}	23±5 ^{ab}
3	1.10±0.09 ^{bc}	13±1 ^{abc}	44±4 ^{ab}	74±3 ^{bcd}	69±1 ^{ab}	40±1 ^{bc}	23±2 ^{ab}
4	1.00±0.10 ^a	12±1 ^{abc}	62±5 ^{cd}	75±3 ^{bcd}	68±1 ^{ab}	38±1 ^{abc}	32±4 ^{de}
5	1.01±0.03 ^a	12±1 ^{abc}	53±9 ^{bc}	73±1 ^{abc}	71±7 ^{ab}	39±5 ^{abc}	27±3 ^{bcd}
6	1.16±0.08 ^{cd}	14±1 ^{cd}	39±6 ^a	77±2 ^{cd}	66±2 ^a	36±2 ^a	20±3 ^a
7	1.13±0.04 ^{cd}	13.0±0.5 ^{abc}	68±10 ^d	70±3 ^a	66±3 ^a	36±3 ^{ab}	31±7 ^{de}
8	1.11±0.04 ^{bcd}	14.0±0.2 ^{bc}	61±10 ^{cd}	71±5 ^{ab}	70±3 ^{ab}	39±2 ^{abc}	30±6 ^{cde}
9	1.11±0.04 ^{bcd}	13±2 ^{abc}	71±10 ^d	73±7 ^{abc}	66±6 ^a	37±5 ^{ab}	34±6 ^e
10	1.05±0.05 ^{ab}	13±2 ^{abc}	60±4 ^{cd}	75±5 ^{cd}	68±2 ^{ab}	37±2 ^{ab}	31±3 ^{de}

Crumb hardness is commonly used as an indicator of bread staling, and it is negatively co-related with bread quality (Wang et al., 2007). The hardness of rice bread rose with increasing amount of added pumpkin flour. Hardness of rice bread (35 N) was increased by the presence of pumpkin flour, however significant ($P < 0.05$) increase was observed only in the presence of 6 g/100 g, (38 N), 2 g/100 g (42 N) and 1 g/100 g (43 N) of pumpkin flour. Additionally, the rising amount of added pumpkin flour amount caused the creation of darker and greener crumb (Table 2).

Table 2 The impact of added pumpkin flour on crumb lightness L*, red/green coordinate a*, yellow/blue coordinate b*

Pumpkin flour addition (g/100g)	L*	a*	b*
0	79.4±0.6 ^f	-0.07±0.08 ^g	14±0.3 ^a
1	76.8±0.9 ^e	-0.87±0.05 ^f	15±0.1 ^b
2	76±2 ^e	-1.00±0.2 ^f	15±0.3 ^b
3	74.6±0.5 ^d	-2.00±0.1 ^e	16±0.3 ^c
4	73.1±0.6 ^c	-2.3±0.1 ^{de}	17±1 ^{cd}
5	70±1 ^b	-2.6±0.2 ^{bc}	19±1 ^e
6	73.1±0.6 ^c	-2.5±0.1 ^{cd}	17±1 ^d
7	72.6±0.6 ^c	-2.3±0.3 ^d	18±1 ^e
8	70.0±0.6 ^b	-3.0±0.3 ^a	19±1 ^e
9	69.5±0.7 ^b	-3.1±0.2 ^a	19±1 ^e
10	67.7±0.8 ^a	-2.8±0.4 ^{ab}	20±1 ^f

Springiness, cohesiveness, and resilience were decreased by the presence of pumpkin flour (Table 1). However significant ($P < 0.05$) effect was observed only in the presence of 1–6 g/100 g. The observation may be related to dough weakening initiated by fiber, decreasing dough ability to trap leavening gas (Plyer, 1988).

Chewiness of rice bread (20%) was increased by the presence of pumpkin flour to 21–33 %, however significant ($P < 0.05$) increase were observed only in bread 1 g/100 g, 2 g/100 g, and 6 g/100 g. Gomez et al. (2003) also showed similar trend for breads with addition of fibers since they caused an increase in chewiness of tested breads.

Crumb color was found to be darker and less acceptable in breads containing pumpkin flour (Table 2). Darkness of the crumb was, moreover, directly related to the amount of pumpkin flour. The results of texture profile analysis indicated the significant impact of added pumpkin flour on rice bread crumb. The panelists, however, did not recognize any significant differences between samples (Table 3). Only taste and flavor was decreased by the presence of 8–10 g/100 g of pumpkin flour, resulting in lower overall acceptability of these breads. The impact of the presence of pumpkin flour on sensory evaluation of rice bread was weak. However, if backed by an extensive sensory study, this could be an important positive result, since pumpkin flour may improve nutritional quality of rice bread without a declining impact on bread sensory evaluation.

Table 3 Sensory evaluation of rice bread with added pumpkin flour

Pumpkin flour addition (g/100g)	Crust appearance and color	Crumb appearance and color	Crumb elasticity	Crumb porosity	Taste and flavor	Overall acceptability
0	7 ^a	5 ^a	4 ^a	4 ^a	6 ^a	6 ^a
1	7 ^a	6 ^a	5 ^a	5 ^a	6 ^a	6 ^a
2	7 ^a	6 ^a	5 ^a	4 ^a	6 ^a	6 ^a
3	6 ^a	6 ^a	5 ^a	4 ^a	6 ^a	6 ^a
4	7 ^a	6 ^a	5 ^a	4 ^a	6 ^a	6 ^a
5	7 ^a	6 ^a	4 ^a	4 ^a	5 ^{ab}	6 ^a
6	7 ^a	6 ^a	5 ^a	5 ^a	5 ^{ab}	6 ^a
7	6 ^a	6 ^a	5 ^a	5 ^a	6 ^a	6 ^a
8	7 ^a	5 ^a	5 ^a	5 ^a	4 ^b	5 ^{ab}
9	6 ^a	6 ^a	5 ^a	5 ^a	4 ^b	5 ^{ab}
10	7 ^a	5 ^a	5 ^a	4 ^a	4 ^b	4 ^b

CONCLUSION

The addition of pumpkin flour to rice flour at different levels modified the textural properties of the enriched breads. The impact on sensory evaluation was, however, weak. Pumpkin flour seems to be able to improve rice bread quality. An extensive sensory study is, however, necessary to back these preliminary results.

Acknowledgments: The research was supported by IGA/FT/2017/004.

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