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RESEARCH ARTICLE

Sensory and color analysis of Arabic bread fortified with detoxified vetch

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ABSTRACT

The effect of replacing wheat flour with vetch flour (*Vicia sativa*) at 10, 20, and 30 $g^{-100\ g}$ on the colour and sensory qualities of Arabic bread was investigated in this study. Color, taste, texture, scent, and general approval were all assessed by sensory evaluation. As the percentage of vetch flour in the mix grew, the acceptance of the colour of the crust and crumb decreased. Almost every test showed that the commercial Arabic bread (T0) outperformed the vetch mixtures. Vetch replacements of up to 20% were ruled acceptable by the judges.

Keywords: Bread making; Detoxification; Protein; Sensory; Vetch; *Vicia sativa*

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INTRODUCTION

Hunger, malnutrition, and global food security are some of the most predicted future challenges due to a steady increase in world population and limited supply of food and water resources (Schwarzlaff et al., 1995). Many studies have been directed to find new sources to enrich our diet with better nutritional components, especially bread, which is considered a major meal component in the Middle East (Coello et al., 2007; Mohammed et al., 2011; Man et al., 2015). Some have mixed soya bean flour, chickpea flour, broad bean, or guar and locust bean gums with wheat flour (Schwarzlaff et al., 1995; Abdel-Kader, 2000; Juarez et al., 2007). Vetch plant help control erosion, which could serve as a heavy mulch that helps soil and water conservation (USDA, 2002; Huang et al., 2019).

Vetch seeds providing energy for the cells, and contributing to the production of mood regulating hormones (Institute of Medicine, 2005). They also contain considerable amounts of vitamins A, C, E, and β-carotene (Enneking, 1994). Vetch seeds are rich in antioxidants and flavonoids (Cavada et al., 2008; Abbas et al., 2012), which have a variety of biological

functions (Parr and Bolwell, 2000). Vetches are also rich in fiber, which significantly enhance weight loss in obese individuals, help with a number of gastrointestinal disorders, and lower the risk for stroke, and hypertension (Anderson et al., 2009; Delinski Bet et al., 2016). Unfortunately, vetch is neurotoxic to chicks due to γ-glutamyl β-cyanoalanine (γGBCA) forms, vicine and convicine (Farran et al., 2002), which limits its use in the diets of mono-gastric species. β-cyanoalanine (BCA) is also found in lentils but in very low percentages (0.06-0.08%) compared to vetch (Ghasemi et al., 2016). Farran et al. (2000) developed two methods for the detoxification of vetch by using acetic acid or hot water wash. With the increase of global population and food shortage, this study will be focused on the preparation of vetch-fortified Arabic bread and study it's sensory and color properties.

MATERIALS AND METHODS

Procurement of raw material

Vetch seeds (*Vicia sativa*) were purchased from the wholesale distributor at Bekaa valley in Lebanon. A 50Kg sack of grade zero commercial wheat flour from National Flour Mill in Lebanon, with 0.67% ash content, 13.5% moisture, 12.1% protein and 26.2% gluten content, was used. All other raw materials (Salt, sugar, yeast and water) were acquired from the homegrown market.

Detoxification of vetch seeds

According to Farran et al. (2002), vetch seeds were detoxified using two different ways (steeping procedures), with the latter exhibiting the maximum efficiency. Before being used, vetch seeds were sifted and rinsed 10 times in water to remove any soil traces. The seeds were steeped in water at 40°C for 72 hours at a 1:10 (w/v) ratio, with the water replaced every 12 hours in the first technique. The seeds were then spread out on oven trays and dried for 48 hours at 60°C.

Baking

With some adjustments, Arabic bread was made according to the Qarooni method (Qarooni et al., 1989). 1000g wheat or vetch enriched flour, 1.1 percent fresh compressed yeast, 0.5 percent salt, and 3 percent sugar were combined. In the mixer bowl, all of the dry ingredients were dry-mixed. Water was added until the dough reached the desired consistency, and the dough was kneaded for another 10 minutes. After that, the dough was shaped into 88g tiny patties and placed on an automated line. The dough was allowed to firm before being sheeted and baked for roughly 7 seconds in a tunnel oven at 600°C, then cooled for 4 minutes before packing.

A total of 7 blends were used in the experiment:

T0: 100% wheat flour (WF);

T10: 10% vetch flour detoxified with hot water (VFHW)+90% WF;

T20: 20% VFHW+80% WF;

T30: 30% VFHW+70% WF;

V10: 10% vetch flour detoxified with acetic acid (VFAA)+90% WF;

V20: 20% VFAA+80% WF;

V30: 30% VFAA+70% WF.

Sensory evaluation

After 24 hours of preparation, the bread loaves were judged by 15 professional panellists from a bakery who assessed the colour of both sides of the loaf (white and brown sheets), taste, smell, general texture, foldability, and breakability. The samples were cut into circular pieces of 6cm diameter, coded, and packed in transparent polyethylene bags. Each parameter was recorded on a 5-point Likert scale (5=best liked to 1=most disliked; Likert Scale 1932). Each one of the panelists was brought in separately into a quiet room for sample evaluation. Along the evaluation, panelists were required to wash their palate by drinking a little amount of water before the start of the test and between each sample.

Statistical analysis

One-way ANOVA was used to compare the data, Duncan's Multiple Range test was used to establish

significance, and Pearson correlation coefficient was used to discover which values were correlated to each other.

RESULTS AND DISCUSSION

Color measurements

The color of the white and brown sheets of the baked bread was determined using image J software and reported as arbitrary units of RGB. Comparing the RGB values for control and vetch-blended samples, we noticed the color in the white sheet gets darker as the percentage of vetch increased [Table 1; T0 (217.07a), T10 (202.34b), T20 (190.68cd), T30 (180.35e), V10 (204.95b), V20 (198.06bc) and V30 (188.03d)]. Pearson correlation showed a negative relationship ($P<0.05$) between color of the white sheet of bread with the β- value that characterizes starch gelatinization property. No noteworthy change was detected in the color measurements of the brown sheet between the control and the vetch-blends or among the different blends. Almost same data were gathered upon substituting wheat flour with chickpeas flour (Mohammed et al., 2011) and vetch flour in doughnuts (Rehman et al., 2007).

As for comparing the color codes of both sheets of the loaf (Figure 1), it has been shown in the dendrogram that the brown sheets are related to the same group except for T0 and V20. In contrast, the white sheets were divided into two groups within the same cluster, in which T0, T10, V10, and V20 were related to the same group concerning the whiteness of the sheet. The other group has consisted of the remaining composites in addition to T0 and V20 loaves, which were so far related to this group. The crust of the control was less yellow than samples. Similar results of wheat bread were fortified with lupin flour (Alomari and Abdul-Hussain, 2013) or with pulse flour (Wani et al., 2016). Moreover, the color of the bread was darker when wheat flour was substituted with 10 and 20% chick pea or pigeon pea flours (Sharma et al., 1995).

Table 1. RGB values for control and fortified baked bread

	White-RGB3	Brown RGB3
T0 (control)	217.07*a	170.06a
T10	202.34b	151.31a
T20	190.68cd	152.92 a
T30	180.35e	142.48 a
V10	204.95b	147.71 a
V20	198.06bc	163.89 a
V30	188.03d	136.39 a

*Means of three replications in the same columns sharing letters are non-significant. Abbreviations for compositions T0-V30 referred to baking part

Sensory evaluation of the baked bread

The results revealed an inverse correlation between consumer acceptance and vetch content. The highest score for crumb (white sheet) color acceptance was obtained for the commercial and T0 bread; commercial (5.00a), T0 (5.00a), T10 (3.53c), T20 (3.40c), T30 (3.40c), V10 (4.46ab), V20 (4.00bc), and V30 (3.40c). As for the crust (brown sheet) color acceptance, once again, commercial bread and T0 bread recorded the highest score; commercial (4.93a), T0 (4.66a), T10 (3.66c), T20 (3.80c), T30 (3.93bc), V10 (4.40ab), V20 (3.93bc), and V30 (3.60c). Acceptance of brown sheet color was significantly higher for commercial and T0 bread; however, no difference could be detected among the vetch blends.

These results where the color scores of vetches substituted bread are lower than control are in agreement with the results obtained with bread with pulse flour (Rehman et al., 2006; Wani et al., 2016) or with lupin flour (Alomari and Abdul-Hussain, 2013). The rolling and foldability of bread were highest for commercial, T0, and T10 samples. However, it was perceptively lower for the remaining blends with no detectable difference among the remaining blends except T10, T30 and V30, where T10 scored higher than T30 and V30.

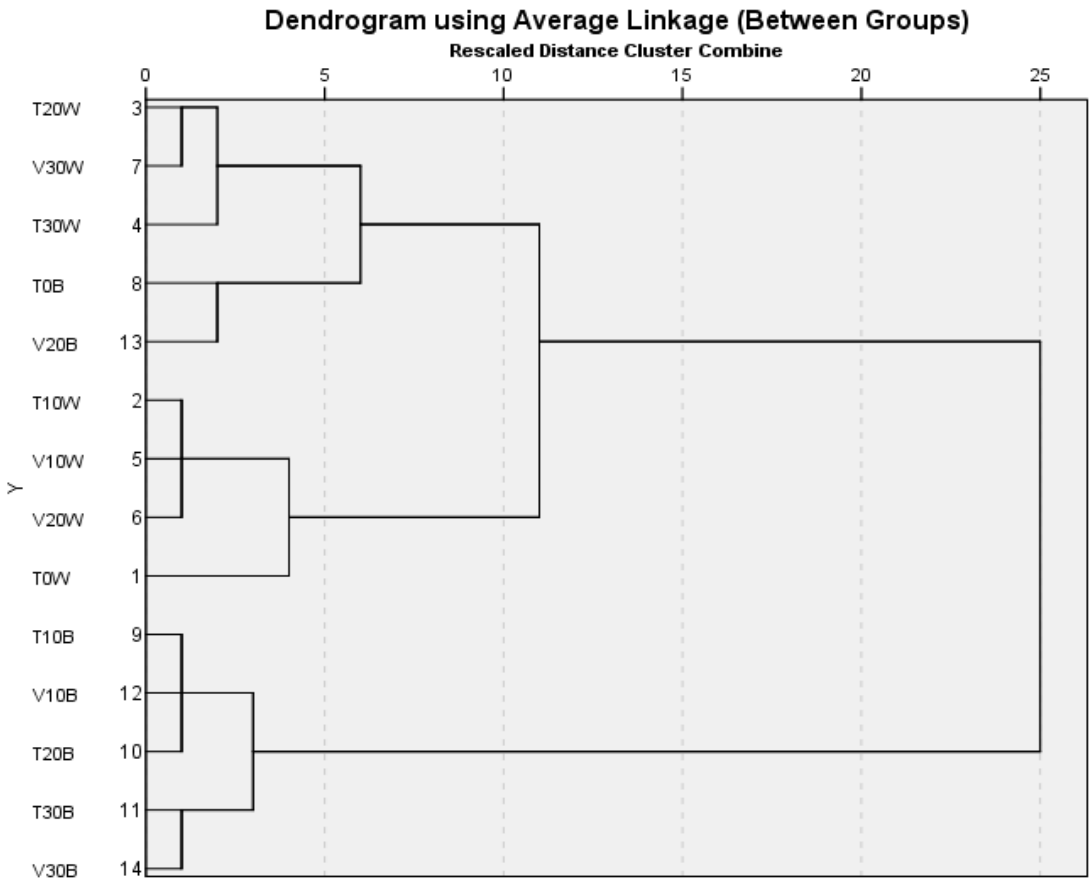

Figure 1. Dendrogram showing the difference between different compositions comparing the color codes of bread sheets Red (R), Blue (B), Green (G).
Note: T0-V30 referred to Materials &Methods/Baking; W: white sheet of the bread (crumb) / B: brown sheet of the bread (crust).

Once again, commercial and T0 samples reported the highest acceptability in aroma, which was significantly higher than all other blends with no detectable difference among the remaining blends. In the mouth-feel test, again, the commercial and T0 samples scored the highest. All blends scored lower than the commercial sample; however, T10 and V10 samples were comparable to T0. There was no discernible difference between the various vetch mixtures. This distinction could be explained by the beany flavour of vetch (Grewal, 1992).

Overall, none of the treatments was disliked by the judges. The results are in confirmed with the previous report of Rehman et al. (2006), Alomari and Abdul-Hussain (2013) where the average scores of the lupin enriched bread were between 5.3 and 5.8. Figure 2 shows the cluster grouping for the overall evaluation of baked bread by panelist, which revealed that bread prepared from control flour and commercial bread belonged approximately to the same cluster. The other cluster contained all the other baked compositions, in which bread with the highest vetch's percentages belonged to the same subgroup (T20, T30 and V30). The V10 had almost different acceptance by panelist from the last subgroup but closer to the control group, and the remaining compositions (T10 & V20) showed a moderate acceptance between the latest subgroups

Table 2. Hedonic scores of sensory evaluation score of baked bread

Composition	White sheet color	Brown sheet color	General Appearance	Rolling & Foldability	Aroma	Mouth-feel	Overall score
Commercial (control)	5.00*[a]	4.93[a]	5.00[a]	4.93[a]	4.73[a]	4.80[a]	4.90
T0	5.00[a]	4.66[a]	4.60[ab]	4.80[a]	4.46[a]	4.46[ab]	4.67
T10	3.53[c]	3.66[c]	4.33[bc]	4.53[ab]	3.86[b]	3.93[bc]	3.98
T20	3.40[c]	3.80[c]	3.73[c]	4.20[bc]	3.53[b]	3.73[c]	3.73
T30	3.40[c]	3.93[bc]	3.80[c]	3.86[c]	3.73[b]	3.46[c]	3.70
V10	4.46[ab]	4.40[ab]	4.46[ab]	4.06[bc]	3.73[b]	4.00[bc]	4.19
V20	4.00[bc]	3.93[bc]	4.33[bc]	4.26[bc]	3.73[b]	3.73[c]	4.00
V30	3.40[c]	3.60[c]	3.80[c]	3.86[c]	3.33[b]	3.73[c]	3.62

*Means of three replications sharing the same letters in a column are non-significant; Abbreviations for compositions T0-V30 referred to Materials & Methods/Baking.

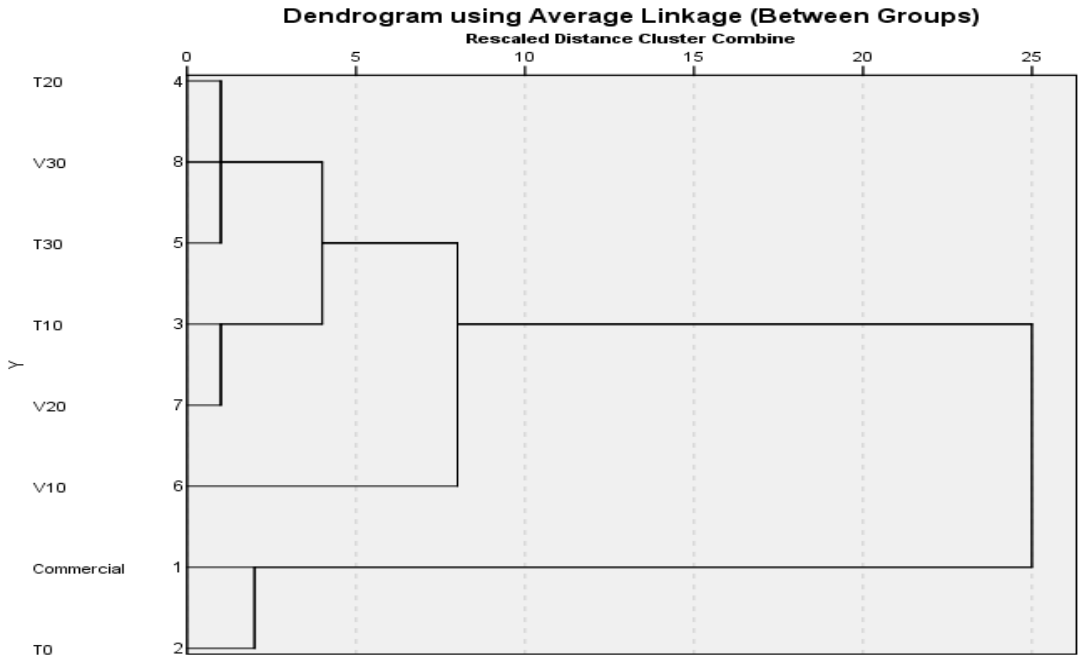

Figure 2. Dendrogram showing the difference between overall means of sensory evaluations done by panelists. *Note: T0-V30 referred to Materials & Methods/Baking*

CONCLUSION

The experiment revealed that vetch flour may be used to partially replace wheat flour in bread making. The samples covered with vetch flour up to 20% had good organoleptic qualities, according to sensory analysis. Overall, replacing up to 20% of wheat flour with vetch flour resulted in bread with good qualities, lowering bread manufacturing costs and perhaps helping during economic and natural disasters. To develop the fortified vetch bread, more testing of the flour, dough, and bread is required.

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