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Research Article

Impact of Apple Pomace on the Property of French Bread

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Abstract: This study analyzed properties of wheat dough and French bread added with different kinds of apple pomace. In the analysis of wheat dough, both farinograph indexes and extenograph indexes were used as evaluation criteria. Specific volume, whiteness and bread core pores were employed to evaluate the property of French bread. Analysis on the nutrient profile of apple pomace indicated that the content of dietary fiber could reach 15.8%. The result of farinograph indexes and extenograph indexes showed that the addition of apple pomace in dough could increase flour strength and dough extensibility. However, high content of apple pomace reduced FQN value. The evaluation of bread property indicated that the addition of apple pomace reduced the whiteness and specific volume of bread. We also discovered that 60-mesh apple pomace had a much worse effect on the specific volume of bread than 100-mesh pomace. Furthermore, sensory evaluation revealed that French bread added with 1% apple pomace (100-mesh) had highest sensory core. In tem of bread core pores, bread added with 1% apple pomace (100-mesh) had small and fine pores. Therefore, appropriate amount of apple pomace could improve the nutritional value and sensory property of French bread without seriously decreasing the whiteness and specific volume.

Keywords: Apple pomace, bread, dietary fiber, property, sensory characteristics

INTRODUCTION

Apple pomace which contains high contents of vitamins, dietary fibers and pectin, is a kind of byproduct produced in the apple processing industry (Yan and Kerr, 2013; Figuerola *et al*., 2005). With the development of apple processing industry, the total amount of apple pomace is increasing rapidly (Alvarez *et al*., 2012). It was reported that apple pomace may cause serious environmental pollution without treatment (Sudha, 2011). In order to utilize the apple pomace comprehensively and reduce its negative effect on environment, apple pectin extraction and apple pomace fermentation industries have been developed (Alvarez *et al*., 2012). However, the residuals produced by these industries may cause the secondary pollution. Therefore, how to utilize the apple pomace scientifically without causing secondary pollution has become a hot topic.

It was proposed that adding certain amount of apple pomace into food could not only modify the nutrient value of food, but also prevent the secondary pollution caused by apple pomace. Furthermore, apple pomace containing high content of dietary fiber could improve the properties, including water holding capacity and sensory characteristics, of some foods (Petersson *et al*., 2012; Yamazaki *et al*., 2005). To our knowledge, adjusting the property of food, particularly the baking food, with apple pomace has been regarded as an innovative trend in food processing industry.

French bread ("baguette" or other shapes) which was developed in France is favored by many people around the world. The commercialization of French bread increased the consumption of French bread in many countries, particularly China. However, the studies on the production technologies of French bread with apple pomace are not enough. Firstly, the nutrient value of French bread, which contains limited amount of protein and dietary fiber, is very low. In addition, the rapid loss of water in French bread during storage is also a serious problem. To get more information about the addition of apple pomace in French bread, this study analyzed the relationship between the addition of different contents of apple pomace and the property of French bread.

MATERIALS AND METHODS

Materials and chemicals: Wheat flour was purchased from market of COFCO Group (Zhengzhou, P.R. China). Soybean oil, salt, sugar and chicken eggs were obtained from markets in Zhengzhou (P.R. China). Dry

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Table 1: Evaluation criteria for French bread

Items	Score	Evaluation criteria
Specific volume	1-20	When the specific volume is 4.10 mL/g, the score is 20; the score decreases by 0.1 point when the value of specific volume decreases by 0.01 mL/g.
Exterior appearance	1-15	12.1-15: Crust is smooth; shape is symmetrical and stands upright; 9.1-12: middling; 1-9: crust is coarse; shape is asymmetrical and hard agglomerations occur.
Color	1-10	8.1-10: Yellow or golden yellow; 6.1-8: middling; 1-6: gray or dark.
Structure	1-15	12.1-15: Pores of longitudinal cut side are small and symmetrical; 9.1-12: middling; 1-9: pores of longitudinal cut side are large and asymmetrical.
Elasticity	1-20	16.1-20: Good rebound after pressing with a finger, strong to the bite; 12.1-16: middling; 1-12: poor rebound after pressing with a finger, soft to the bite.
Stickiness	1-15	12.1-15: Sample feels dainty and does not stick to teeth when steamed bread is chewed twice; 9.1-12: middling; 1-9: sample sticks to teeth when chewed.
Smell	1-5	4.1-5: Has fragrance of wheat and pleasant taste; 3.1-4: middling; 1-3: unpleasant taste.
Total score	100	

yeast was purchased from Angel Yeast Co., Ltd (Zhengzhou, P.R. China).

Apple was obtained from local market (Zhengzhou, P.R. China). Fresh apple was dried by vacuum dryer and smashed by grinder. Apple pomace was sieved with US-60 mesh and US-100 mesh. Dry apple pomace was stored at 4^{o}C in dark until use.

Bread making process: The making procedure of French bread was listed as follows: wheat flour (300 g), yeast (3 g), egg yolk (20 g), salt (2 g), sugar (60 g), water (100 g) and certain amount of apple pomace were mixed and kneaded for 30 min. For the addition of aple pomace, different contents were added to evaluate the effect on bread properties. The wheat dough was proofed at 38^{o}C with 90% R.H. for 80 min. The proofed dough was gently deflated and baked at 190^{o}C for 15 min. Finally, the bread was put at room temperature to cool down.

Analysis of apple pomace properties: Water content, ash content, fat content, protein content, dietary fiber content were analyzed according to GB5009.3-2010, GB5009.4-2010, GB5009.6-2010, GB5009.5-2010 and GB5009.88-2010, respectively.

Analysis of wheat flour and dough properties: Water content, ash content, whiteness, wet gluten content (%), farinograph and extenograph indexes were analyzed according to GB5009.3-2010, GB5009.4-2010, GB/T12097-1989, GB/T14608-1993, GB/T14614-93 and GB/T14615-93.

Sensory evaluation process: Sensory score of French bread was evaluated according to the revised method from He and Lu (2014) by an evaluation team with 10 members. Evaluation criteria were shown in Table 1. Average value of the sores given by 10 members was used to reflect the sensory property of French bread.

RESULTS AND DISCUSSION

Essential nutrients of apple pomace and wheat dough properties: The contents of water, ash, crude protein, oil and dietary fiber in fresh apple pomace were 68.4, 2.5, 7.4, 5.9 and 15.8%, respectively. The ash content, water content, whiteness, wet gluten content, farinograph indexes and extenograph indexes of wheat dough added with different amounts of apple pomace were shown in Table 2.

With the addition of apple pomace increasing from 0 to 4%, the ash content and water content of wheat dough increased from 0.54% to 0.85% and from 13.0 to 13.8%, respectively. Due to the high content of dietary fiber in apple pomace, the ash content increased greatly with the addition of pomace. Although apple pomace could improve the water content, the difference between the water content of dough without apple pomace and that of dough added with 4% pomace was not significant. Therefore, the addition of apple pomace could not change the water content of wheat dough. The whiteness of wheat dough decreased from 75.7 to 68.2 when the addition of apple pomace increased from 0% to 4%. The difference between values of wet gluten content under different addition contents of apple pomace was not significant. Therefore, the effect of apple pomace on the wet gluten content of wheat dough was limited.

Four farinograph factors, water absorption, development time, stability time and FQN (Farinograph Quality Number), were analyzed. The values of water absorption increased from 63.6 to 67.3% with the addition of apple pomace increased from 0 to 4%. It was reported that wheat flour with high contents of protein and damaged starch had high water absorption. In this study, the addition of apple pomace which contained about 7.4% crude protein increased the protein content in dough. Furthermore, the high content of dietary fiber in apple pomace also contributed to the increment of water absorption. The increment of development time indicated that the flour strength increased with the addition of apple pomace. The addition of apple pomace also reduced the stability time from 17.9 min to 13.6 min. It was reported that to wheat flour with long development time or with stability time ranged from 7-15 min could make the bread quality better (Md Zaidul *et al*., 2004). Therefore, based on development time and stability time, the addition of apple pomace could improve the quality of flour used for bread production. However, with the addition of apple pomace, FQN decreased from 200 to 160. That means the degree of softening of dough when mixed for

long time increases with the addition of apple pomace. Low value of FQN is unfavorable to the bread quality. Therefore, it is important to control the content of apple pomace added in wheat flour to make sure that the FQN could fall into an acceptable range for bread production.

The addition of apple pomace also changed the values of some extenograph indexes, including extensibility, max resistance and viscoelastic ratio. With the content of apple pomace increasing from 0% to 4%, max resistance and viscoelastic ratio decreased to 546 EU and 5.57, respectively, while extensibility increased to 98 mm. These changes indicated that the extensibility of dough could be improved by adding apple pomace.

Effect of apple pomace on whiteness: The whiteness of bread core is an important factor impacting the property of bread. White bread core always improves consumers' satisfaction while dark bread core usually negatively impact their satisfaction. Therefore, controlling the whiteness of bread core is important in the bread making process. The result in Fig. 1 indicated that the whiteness of bread core decreased from 55

Table 2: Farinograph and extenograph properties of wheat dough added with apple pomace

Addition of apple pomace (%)	Ash content (%)	Water content (%)	Whiteness	Wet gluten content (%)	Water absorption (%)	Development time (min)	Stability time (min)	FQN	Extensibility (mm)	Max Resistance (EU)	Viscoelastic ratio
0	0.54	13.0	75.7	33.1	63.6	3.0	17.9	200	85	712	8.37
1	0.60	13.6	72.4	33.2	64.4	11.0	15.5	178	86	816	9.49
2	0.65	13.7	70.3	33.0	65.3	10.6	14.4	167	88	747	8.49
3	0.76	13.6	69.5	33.5	66.8	10.5	14.0	166	96	620	6.46
4	0.85	13.8	68.2	33.6	67.3	10.0	13.6	160	98	546	5.57

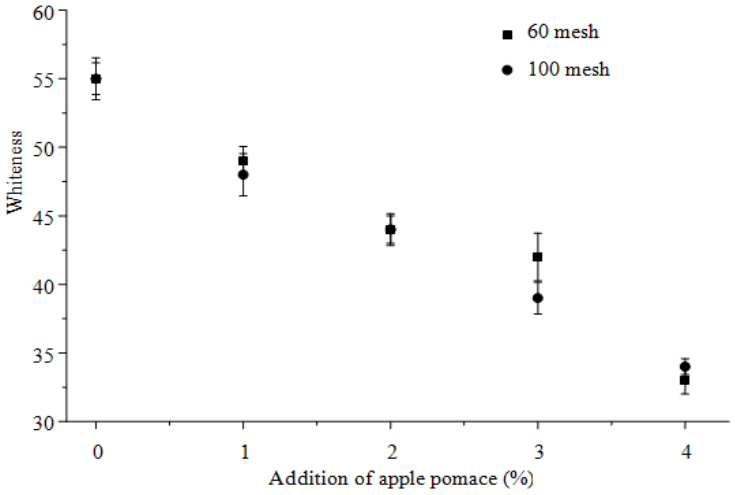

Fig. 1: Effect of apple pomace on whiteness

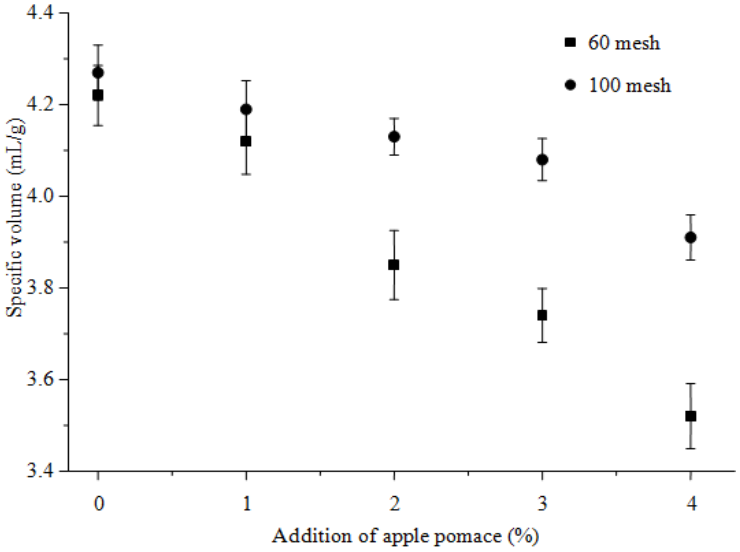

Fig. 2: Effect of apple pomace on specific volume

when the addition of pomace (100-mesh) was 0% to 34 when the addition of pomace was 4%. Therefore, adding apple pomace in wheat dough in the production of bread could reduce the whiteness of bread.

The difference between the addition of two kinds of apple pomace (60-mesh and 100-mesh) was not significant. The decrement rates of whiteness of bread core added with two types of apple pomace (60-mesh and 100-mesh) were 40.00 and 38.18%, respectively. Therefore, the particle size of apple pomace could not impact the whiteness of bread core significantly.

Effect of apple pomace on specific volume: Specific volume of bread could impact the thickness and sensory characteristics. Figure 2 indicated that the specific volume of bread added with 100-mesh and 60-mesh

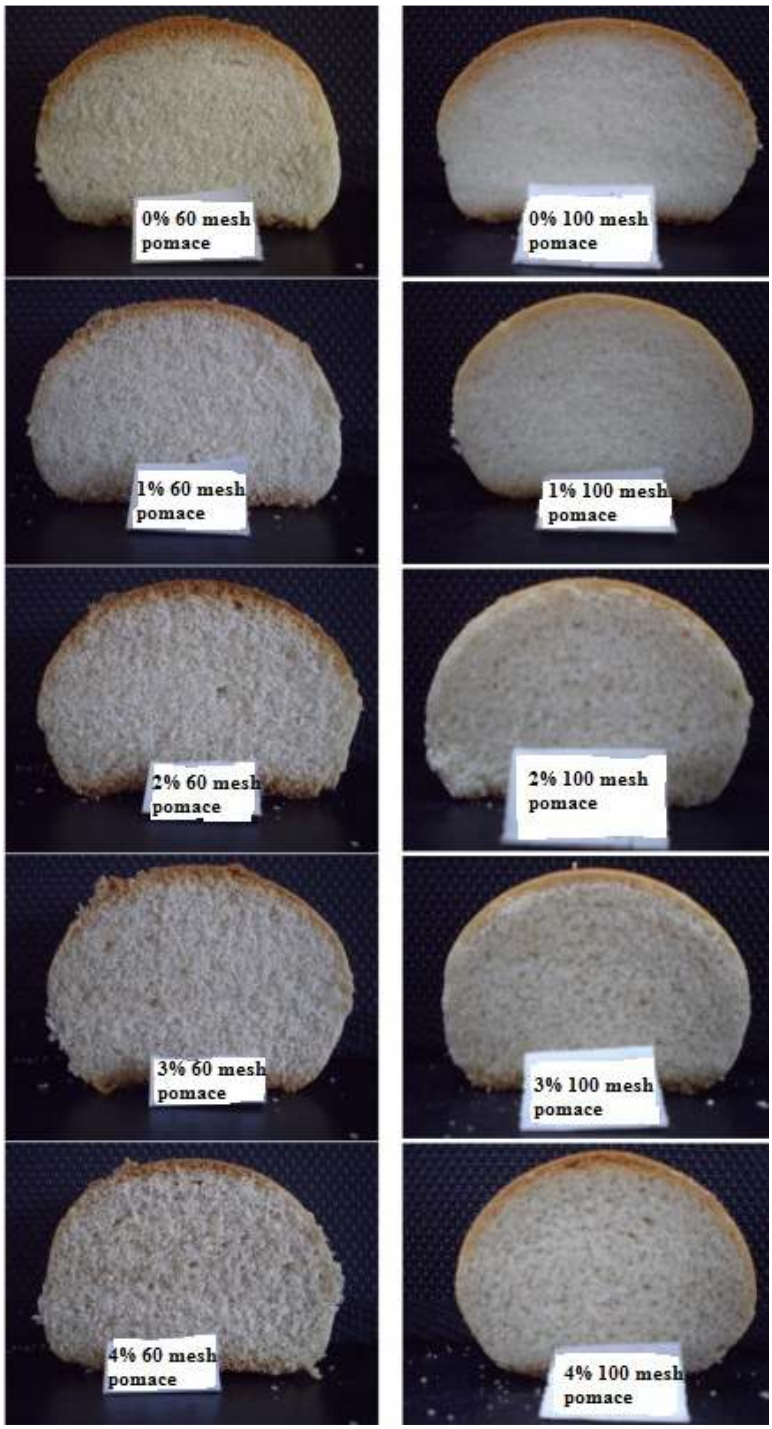

Fig. 3: Pores in the bread added with apple pomace

Table 3: Sensory characteristics of bread added with apple pomace

	Addition of apple pomace (%)	Specific volume	Exterior appearance	Color	Structure	Elasticity	Stickiness	Smell	Total score
	0	20	15	9.6	14.5	19.7	15	3.7	94.1
60 Mesh	1	20.0	13.8	9.2	12.6	17.4	13.6	3.7	90.3
	2	17.5	12.1	8.2	11.6	15.6	11.2	4.0	80.2
	3	16.4	10.8	6.6	9.60	14.9	10.4	4.2	72.9
	4	14.2	9.90	4.0	8.60	12.8	9.20	4.9	63.6
100 Mesh	1	20.0	15.0	8.5	14.4	18.1	15.0	3.9	94.9
	2	20.0	12.5	8.0	12.5	16.7	13.5	4.6	87.8
	3	19.8	12.1	6.0	10.5	14.6	12.0	4.8	79.8
	4	18.1	11.7	4.0	9.50	13.5	11.0	4.9	72.7

apple pomace decreased by 0.36 mL/g and 0.7 mL/g, respectively, when the amount of pomace increased from 0% to 4%. This result showed that high content of apple pomace in bread and the addition of apple pomace with large particles size could reduce the specific volume. It was reported that bread with high value of specific volume was always soft and tasty (Liu and Scanlon, 2002). Therefore, the apple pomace added in wheat dough should be fined and the amount of apple pomace should be controlled.

Effect of apple pomace on sensory characteristics: Sensory scores of bread added with different amounts and types of apple pomace were shown in Table 3. The result indicated that the sensory score of bread reached highest value, 94.9, when 1% apple pomace (100-mesh) was added into dough. Although apple pomace reduced scores on specific volume, structure, exterior appearance and color, it improved scores on the smell. Based on previous discussion, the main reason for the negative effect of apple pomace on specific volume, structure and exterior appearance was the high content of dietary fiber in pomace. Furthermore, compared with 100-mesh apple pomace, 60-mesh pomace had much worse effect on the sensory properties of French bread. Therefore, to get high sensory score, the relationship between different factors should be balanced. According to the result, French bread added with 1% apple pomace (100-mesh) had the best sensory property.

Effect of apple pomace on pores in bread: Figure 3 showed that the size of bread pores increased with the addition of apple pomace in bread making process. It was reported that French bread with large-size pores had unfavorable internal structure and bad taste (Wang *et al*., 2011). Therefore, the addition of apple poamce would negatively impact the internal structure. However, Fig. 3 indicated that there was no significant difference between bread added with 1% apple pomace and that without any apple pomace. From this perspective, the amount of apple pomace added into wheat dough should be controlled to protect the internal structure of French bread. Not only the amount of pomace, but also the particle size of pomace could impact the size of bread pores. Figure 3 indicated that with the same amount of apple pomace, bread added with 100-mesh pomace had much smaller pores than that added with 60-mesh pomace. Therefore, to improve the internal structure of bread added with apple pomace, the particles size of poamce should be reduced. Therefore, addition of 1% apple pomace (100-mesh) could improve the content of dietary fiber without negatively influencing internal structure of French bread.

CONCLUSION

In this study, apple pomace, which contained 15.8% fiber, could be used as an important source of dietary fiber. The addition of apple pomace in dough increased flour strength and dough extensibility while reduced FQN value. So the amount of pomace added in dough should be controlled at a lower level. Furthermore, the addition of apple pomace reduced the whiteness and specific volume of French bread. 60-mesh apple pomace had a much worse effect on the specific volume of bread than 100-mesh pomace. Sensory evaluation indicated that French bread added with 1% apple pomace (100-mesh) had highest sensory core. In tem of bread core pores, bread added with 1% apple pomace (100-mesh) had small and fine pores. Current study showed that the addition of 1% apple pomace could improve the sensory property of French bread to the highest level.

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