

CHAPTER IV

EFFECT OF COMMERCIAL IMPROVER ON THE PROXIMATE COMPOSITION AND SENSORY CHARACTERIZATION OF WHITE BREAD FROM FLOUR WITH DIFFERENT GLUTEN STRENGTH

4.1 Introduction

Bread is a product of baking a mixture of flour, water, salt, yeast and other ingredients (Whitehurst and Oort, 2010). This convenient food has been recognized globally for long for been a preferred fast food. It has become an ideal functional and staple food in various places. Many families in cities across the globe take it as meal especially the medium and high-income class (Umelo et al, 2014). It is widely consumed by Malaysians (Zuwariah and Aziah, 2009), and second to rice based on consumption (Ling, 2011).

Numerous studies have been conducted on bread making and consumption. Some researches focused on changes in both physical and chemical property of dough during baking, some authors devoted their work on rheological changes during storage, and others put attention on sensorial aspects. Countless works have been reported on composite bread making, some of these were attempted to improve nutritive value of bread while some targeted socioeconomic problem and some were health related.

Though, research has generated an impressive progress in bread making through introduction of new ingredients and equipment to produce better quality bread. The increasing demand of bread could not allow stoppage of research rather it is begging for more. The expected global population by the middle of this century is 9 billion, implying an increase in consumption of processed and RTE food like bread (Godfray et al 2010). Bread quality is affected by both flour properties and baking process (Svec and Hruskova, 2010). This emphasizes the need for more research on both flour and baking process of bread.

The consciousness of consumers is on increase on the significance of food safety and food quality. They anticipate food products of acceptable quality and sensory characteristics. Hence, new ingredients are developed and introduced to the food market such as CBI. In other to guarantee safety and maintaining the quality of the final product, ingredients and production technology need to be studied (Gallagher et al., 2005). The aims of this present study was therefore to evaluate the impact of commercial improver on bread features, proximate composition and acceptability of white bread from flour of different gluten strength.

4.2 Materials and Methods

4.2.1 Raw Materials

Waitrose Canadian Bread flour, Diamond brand high gluten flour and Blue bicycle wheat flour (all-purpose) with protein content of 14.5, 12.0 and 9.8% respectively were the types of flour selected for this study, CBI under test was Kijang, other ingredients include baker's

yeast, salt, shortening and sugar. All materials were supplied by Food Biotechnology Department, Universiti Sains Islam, Malaysia (USIM).

Straight dough technique was employed. Three bread samples were produced and labelled according to their flour type, and improver brand combination. HS1 (bread from high gluten flour with the improver), AS1 (bread from all-purpose flour with the improver) and the control (KS) sample that was made from the bread flour with no addition of the improver.

4.2.2 Physical Measurement

The measurement of bread volume, weight, specific volume, loaf height, weight loss, crust-crumb colour, and textural analysis were performed as described in previous chapter. Image of breadcrumb was acquired by capturing images on the crumb grain of the sliced bread. This was achieved by scanning slices from the center of each bread with a scanner (Canon Scan Lide 700F, Canon) as described by Skendi et al., (2010). Textural analysis was performed as described in the previous chapter; analyses were conducted 24 hours, 5 days and 10 days after baking.

4.2.3 Proximate Analysis

4.2.3.1 Moisture Content

Moisture content was determined as described in previous chapter. Analyses were conducted 24 hours, 5 days and 10 days after baking.

4.2.3.2 Crude Fibre

Crude fibre was determined using fibrebag (Gerhardt Method). For each bread sample, 1.0 g was weighed and inserted into the fibrebag whose weight has been predetermined. Glass spacer was inserted into the fibre bag and the fibre bag was inserted into the carousel.

The sample was defatted using 100 cm³ of 40/60 petroleum ether. After a short (two minutes) drying process in the fume cupboard, the carousel was immersed in washing solution and fibrebag transferred to a pre-ashed crucible (600°C) and weighed. The fibrebag was later incinerated at 600°C overnight, weighed and the percentage of crude fibre was calculated based on the formula (Nielsen, 2010).

$$\text{Crude fibre (\%)} = \frac{\{(C-A)-(D-E)\} \cdot 100}{B} \quad (7)$$

$$\text{Blank Value } E = D - F \quad (8)$$

A = Mass of FibreBag in g

B = Sample mass in g

C = Mass of Crucible and dried FibreBag after digestion, in g

D = Mass of crucible and ash in g

E = Blank value of the empty FibreBag in g

F = Mass Crucible in g.

4.2.3.3 Fat Analysis

Fat content of bread sample was analyzed by solvent extraction method. About 2 g of each of the bread sample was weighed and folded in filter paper. Then inserted into extraction thimble, contained three to five pieces of boiling stones to stabilize the boiling process and covered by glass wool. Later, 120 cm³ of petroleum ether was later poured into the extraction flask in which thimble containing the samples had been placed. Extraction then done by Gerhardt Soxtherm automatic extractor machine at 150°C.

After the completion of the program, sample was dried in the Binder drying oven (Binder Inc. USA) at 105°C for an hour, allowed to cool in desiccator, the final mass was measured (Nielsen, 2010). The percentage of fat in the bread sample was then calculated based on formula.

$$\text{Fat (\%)} = \frac{(m_1 - m_2)}{m_0} \times 100 \quad (9)$$

m_1 = mass of the empty extraction beaker with boiling stones in g

m_2 = mass of the extraction beaker with fat after drying in g

m_0 = mass at the start of the analysis in g.

4.2.3.4 Protein Analysis

Protein contents of produced samples were determined by the Kjeldahl in Kjeldatherm-system. 1.0g of each sample, 10 cm³ of sulphuric acid and a piece of kjeltabs were added into 250-cm³ digestion tube. Digestion was then run followed by distillation and filtration

using Kjeldatherm-system machine. Percentage of nitrogen and protein contents were expressed automatically using the conversion factor $N \times 5.7$ (Nielsen, 2010).

$$\text{Nitrogen (\%)} = \frac{1.4007 \cdot c \cdot (V - V_b)}{\text{sample weight (g)}} \quad (10)$$

c = concentration of the standard-acid solution: Hydrochloric acid = 0.1N

or $c = 0.1 \text{ mol/L}$.

Alternative: sulphuric acid 0.1N or $c = 0.05 \text{ mol/L}$.

V = consumption of the standard acid used in cm^3 (Sample)

V_b = consumption of the standard acid in cm^3 (Blank Sample)

$$\text{Raw protein (\%)} = \text{percentage N} \times 5.7 \quad (11)$$

4.2.3.5 Ash Content

The ash content is an estimated measure of the mineral salts and other organic matter in a sample. The ash contents are the organic residues after combustion at a temperature of $575 \pm 25^\circ\text{C}$. Dry ashing method specified for proximate analysis was used.

5.0 g bread sample was put into crucible, charred and ashed overnight in muffle furnace oven at 550°C was allowed to cool to 250°C before transferred to desiccator to cool prior to weighing (Nielsen, 2010). Percentage of ash content of the bread sample was calculated based on the following formula:

$$\% \text{ ash (dry basis)} = \frac{\text{weight of sample after ashing}}{\text{weight of sample before ashing}} \times 100 \quad (12)$$

4.2.3.6 Carbohydrate

Carbohydrate content was calculated by the difference method using the formula:

$$\text{CHO (\%)} = (100 - [\% \text{ moisture} + \% \text{ protein} + \% \text{ lipid} + \% \text{ ash} + \% \text{ fat} + \% \text{ fibre}]) \quad (13)$$

(FAO, 1998; AOAC, 2000)

4.2.3.7 Energy Contents (Kcal)

Energy content was determined by multiplying protein, carbohydrate and fat contents by factors of 4, 4 and 9, respectively.

$$\text{Energy (Kcal)} = ((\% \text{ Carbohydrate} \times 4) + (\% \text{ Protein} \times 4) + (\% \text{ Fat} \times 9)) \quad (14)$$

(Malomo et al, 2011)

4.2.3.8 Water Activity

Water activity (A_w) of bread samples was measured at $25^\circ\text{C} (\pm 0.2^\circ\text{C})$ with an electronic dew-point water activity meter, Aqua lab Series 3 model TE (Decagon Devices), equipped with a temperature-controlled system in three replicates (AACC, 2010). Analyses were conducted 24 hours, 5 days and 10 days after baking.

4.2.4 Sensory Analysis

The sensory evaluation of the fresh bread was conducted by 25 panelists from the department of Food Science and Technology, USIM, Malaysia. The bread samples were prepared and coded with 3-digit random numbers and each sample was presented with

different number. Evaluation was done after 24 hours of baking due to logistic beyond control.

Samples were randomly assigned to each panelist. Panelists were asked to evaluate the coded bread samples for each sensorial parameter including appearance, colour, aroma, crumb texture, taste, and overall acceptance based on their degree of liking using 9-point hedonic scale from “dislike extremely to like extremely” (Ishida and Steel, 2014). Score of five or more was considered as acceptable (Gallagher et al, 2005) and the index of acceptability (IA) was calculated using the following equation.

$$IA (\%) = \frac{Score * 100}{9} \quad (15)$$

(Coelho and Salas-Mellado, 2015)

4.3 Statistical Analysis

The result obtained was reported as the means of three loaf replicates and analyzed by analysis of variance (ANOVA) using Minitab 16.2.1 version software. Significant differences between the mean values were determined using Fisher's test at a significance level of $P < 0.05$.

4.4 Result and Discussion

4.4.1 Physical Characterization

4.4.1.1 Gluten Composition of Flour

The percentage gluten content of all-purpose and high gluten flour has been presented in Table 3. As expected, the high gluten flour recorded higher value of gluten content; 38.2 and 28.0% (high gluten flour) and 27.27 and 14.07% (all-purpose flour) for wet and dry gluten content respectively.

These values are higher compared to the finding of Gallagher et al (2005), for white and organic flour tested, they obtained 31.5, and range of 26.6 - 32.5% wet gluten, 11.1 and 9.4-11.6 dry gluten content for non-organic and organic flour tested respectively. Malomo et al (2011) obtained 24.09 wet gluten in white flour and 14 to 18.39% in formulated composite flour. The difference in value may be due to wheat processing, milling, type of flour and storability of flour or different gluten determination method used.

Milicevic et al (2009) obtained a range of 29.20 to 33.90 wet gluten content for white flour stored within 21 days post milling. Flour from hard wheat is expected to have wet gluten content between 35 to 38% and soft wheat flour should contain 24 to 28% wet gluten (AACC, 2010).

4.4.1.2 Physical Characteristics

Table 4.1 shows the result of the analysis of the physical properties of the bread samples. The loaf volume of the high gluten bread sample (HS1) was higher than that obtained for the all-purpose sample (AS1) though the control sample (KS) had the highest volume, likewise all other parameters tested except weight. The values obtained for weight were in the order AS1>HS1>KS. The difference in the value of parameters tested could be attributed to variability in the type of flour used. This confirmed that different type of flour affect bread quality (Sluimer, 2005). The result obtained therefore suggests that improver functionality is flour dependent.

Table 4.1: Volume, Weight, Loaf Height, Specific Volume and Weight Loss of Bread Samples

Sample	Volume (cm ³)	Weight (g)	Loaf Height (cm)	Specific volume (cm ³ /g)	Weight loss (%)
KS	1850.00 ^a ±0.00	601.57 ^a ±13.46	11.79 ^a ±0.84	3.08 ^a ±0.07	11.45 ^a ±1.80
HS1	1766.67 ^{ahr} ±125.80	607.40 ^a ±11.48	10.89 ^a ±0.96	2.91 ^a ±0.18	10.25 ^a ±2.19
AS1	1650.00 ^b ±100.00	608.40 ^a ±23.75	9.83 ^b ±0.60	2.69 ^b ±0.22	10.94 ^a ±3.15

Means with different alphabet are statistically different (P<0.05)

4.4.1.3 Colour Analysis

Colour is fundamental in the physical property of food including bread. There is correlation between colour and other physical and sensory indicators of product quality (Angioloni and Collar, 2009). The colour parameters (Table 4.2) of the crust revealed that high gluten sample (HS1) was not different from the control sample with lower L* values (lightness)

than all-purpose sample, this means that the all-purpose sample was lighter than samples from other samples ($P < 0.05$) that were more brownish.

For the greenish-reddish factor, the result increases in the order of brand $HS1 > AS1 > KS$. Tested samples (HS1 and AS1) showed higher values of a^* (-green, + red) which were 12.94 and 10.73 for HS1 and AS1 respectively, showing that they were more reddish than the control sample, KS (10.45), this is likely to be associated with the improver involved in the tested samples. This same trend was observed in the crust b^* values (-blue, +yellow). Highest value of 29.52 was obtained for HS1, this indicates that HS1 was the most yellowish among all samples ($P < 0.05$).

As for the crumb colour, the lowest value of L^* was obtained by the high gluten sample (70.59) while the highest value was obtained by the all-purpose sample (74.04). This implies that high gluten sample (HS1) was whiter than other samples while all-purpose was creamier.

The mean a^* values (-green, + red) were 0.81, 0.58 and 0.13 for the KS, HS1 and AS1, respectively, showing that the control (KS) sample was more reddish-coloured than other tested samples. The b^* values (-blue, +yellow) values were 17.00, 17.43, 21.46 respectively, indicating that the all-purpose sample was more yellowish in coloured than both the high gluten and control bread samples. Ishida and Steel (2014) obtained L^* , a^* , and b^* values of 74.73, 0.37, and 15.51 while Ho and Abdul Aziz (2013) had 61.74, -0.26 and 11.50 for the crumb of their white bread.

Table 4.2: Colour Parameter of Bread Samples

Sample	Crust colour			Crumb colour		
	L*	a*	b*	L*	a*	b*
KS	52.51 ^b ±1.24	10.45 ^{cd} ±0.38	26.94 ^c ±0.57	73.92 ^a ±0.65	0.81 ^a ±0.11	17.00 ^c ±0.55
HS1	52.44 ^b ±0.54	12.94 ^a ±0.27	29.52 ^a ±0.94	70.59 ^b ±1.47	0.58 ^b ±0.19	17.43 ^{bc} ±0.54
AS1	54.39 ^b ±1.48	10.73 ^{cd} ±0.50	28.29 ^{abc} ±0.42	74.04 ^a ±1.33	0.13 ^c ±0.10	21.46 ^a ±0.18

Means with different alphabet are statistically different (P<0.05)

4.4.1.4 Crumb Structure

Quality bread is expected to have a high porosity, fine, and evenness of gas cell structure in the crumb (Coelho and Salas-Mellado, 2015; Selomulyo and Zhou, 2007). All bread samples showed an acceptable crumb structure (Figure 4.1).

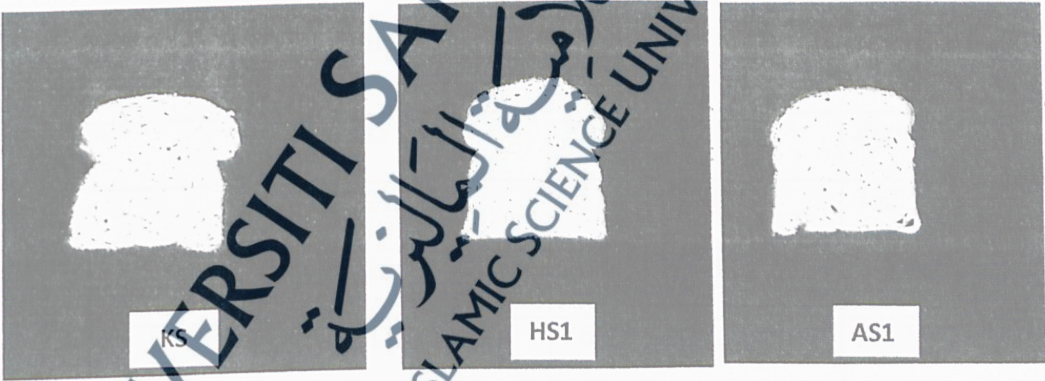


Figure 4.1: Sample images of breadcrumb KS (Control). HS1 (High gluten samples) and AS1 (all-purpose samples),

4.4.1.5 Textural Property of Bread

Table 4.3 presented the firmness result of bread samples. The firmness values of the bread samples were 86.39, 88.01 and 58.68 g for KS, HS1 and AS1 respectively on the first day of analysis. There was no statistical difference between the control and high gluten samples, the two samples were firmer than the all-purpose sample ($P>0.05$). All samples showed an increase in firmness as day's progresses.

The firmness pattern for the fifth and tenth day of analysis was in the order of $AS1>KS>HS1$. The lowest value of firmness exhibited by the high gluten sample is an indication that the sample had a longer lifespan compared to the control and the other tested sample. This could implies that quality flour can be aided by the use of improver to delay staling and improve shelf life of bread. Higher carbohydrate contents of all-purpose may be associated to its highest firmness value during storage.

Table 4.3: Firmness of Bread Samples on Days 1, 5 and 10

Sample	Firmness 1	Firmness 5	Firmness 10
KS	86.39 ^a ±24.17	251.76 ^b ±139.32	352.5 ^b ±195.0
HS1	88.01 ^a ±15.93	133.64 ^c ±59.34	187.3 ^c ±82.7
AS1	58.68 ^b ±11.88	362.04 ^a ±132.16	506.9 ^a ±185.0

Means with different alphabet are statistically different ($P<0.05$)

During storage as observed in Figure 4.2, the increase in firmness was due to starch retrogradation and moisture migration from crumb (Gallagher et al, 2005; Fennema, 1996; Oliveira et al., 2014). Increase in firmness during storage was observed and reported by

Ishida and Steel, (2014), Coelho and Salas-Mellado (2015). The result obtained in this study was also similar to the finding of (Buresova et al, (2014), Gallagher et al, (2005). They discovered in their work that all texture parameters deteriorate during storage.



Figure 4.2: Firmness (g) of Bread Samples on Days 1, 5 and 10

4.4.2 Chemical Analysis

4.4.2.1 Proximate Analysis

Proximate analysis result of all bread samples produced is presented in Table 4.4. The protein values of samples were statistically different ($P < 0.05$). High gluten sample had the highest protein value and all-purpose sample recorded the smallest value of protein. This is expected because of the quality of flour involved.

High protein flour resulted in highest protein content, bread flour with moderate quantity of flour had greater amount of protein and all-purpose flour with lower protein content recorded the lowest value of protein. The highest value of carbohydrate content was obtained by the all-purpose sample while the smallest value was recorded for the high gluten sample. This is in contrast to the value obtained for protein content. Carbohydrate content of flour is inversely proportional to its protein content.

Table 4.4: Proximate Composition of Bread Samples

Sample	Ash (%)	Fibre (%)	Fat (%)	CHON (%)	CHO (%)	Energy
KS	2.01 ^a ±0.01	3.80 ^a ±0.23	4.92 ^a ±0.13	10.45 ^b ±0.55	45.38 ^{ab} ±2.28	267.63 ^a ±7.36
HS1	1.90 ^c ±0.06	3.91 ^a ±0.93	4.84 ^c ±0.13	10.98 ^a ±0.23	44.30 ^b ±1.65	264.65 ^a ±8.60
AS1	1.91 ^b ±0.05	4.05 ^a ±1.13	4.87 ^b ±0.30	7.99 ^c ±0.69	47.43 ^a ±0.37	265.41 ^a ±3.77

Means with different alphabet are statistically different (P<0.05)

The fat content of control sample was higher compared to the tested samples. Higher fat content was recorded for all-purpose sample while high gluten sample had the lowest fat content. This could possibly linked to the amount of carbohydrate and energy content of the flour.

For both fibre and energy values, all samples were statistically not different from the control (P>0.05). Ash content of samples vary from 1.90 to 2.01%. This result is within the values obtained in previous studies. Dooshima et al, (2014) obtained 1.51% and Ndife

et al, (2013) had 3.27% ash content for white bread. Fibre and mineral are important functional ingredient that helps in prevention, treatment and management of some disease, ash is representative of mineral element in food.

Summarily, high protein sample had highest protein content, which is valued for body growth, and revealed lowest value of both fat and carbohydrate. All-purpose sample had more fat, low protein and higher carbohydrate value. The increase awareness on health issues has stimulated consumers to devote attention on the quality and nutritional properties of foods (Dewettinck et al, 2008).

Higher fat intake is associated to obesity and diabetics, high intake of mineral possess a better health promoting benefits, proteins is essential for body building but the high cost of protein food is contributing to nutrition deficiency, consuming bread with high protein level can be a better alternative. Ndife et al, (2013) advised to consume bread rather than high fatty food because carbohydrate is readily available for energy production. Hence, bread from high gluten as presented in this work offer a better health benefit than the all-purpose samples.

4.4.2.2 Moisture Content of Bread Samples

There is no statistical difference in moisture content among samples (33.77-34.12%) on the first day of analysis (Table 4.5), and in comparison to the Malaysian regulatory standard for moisture content of bread, the moisture content were within regulatory specifications of moisture 45% maximum.

Table 4.5: Moisture Content of Bread on Day 1, 5 and 10 after Baking

Sample	Moisture-Day 1	Moisture Day 5	Moisture Day 10
KS	33.44 ^a ±1.74	32.09 ^c ±0.79	30.45 ^c ±1.17
HS1	34.07 ^a ±1.27	33.40 ^b ±0.20	32.19 ^b ±1.19
AS1	33.77 ^a ±0.92	33.51 ^a ±1.06	32.04 ^a ±0.54

Means with different alphabet are statistically different (P<0.05)

The shelf life study revealed a decreasing moisture content for all samples (Figure 4.3). This was also observed by Ishida and steel (2014). Moisture loss is possible during starch retrogradation because of water transfer from crumb to crust (Gallagher et al, 2005).



Figure 4.3: Moisture content (%) of Bread Samples on Days 1, 5 and 10 after baking

4.4.2.3 Water Activity

Figure 4.4 depicted the water activity result of bread sample. The mean water activity values (A_w) on the first day were 0.943, 0.942 and 0.95, for KS, HS1 and AS1 samples, respectively.

Table 4.6: Water Activity of Bread Samples on Days 1, 5 and 10 after Baking.

Sample	H ₂ O activity-Day1	H ₂ O activity-Day5	H ₂ O activity-Day10
KS	0.943 ^a ±0.02	0.932 ^b ±0.01	0.929 ^b ±0.02
HS1	0.942 ^a ±0.01	0.939 ^{ab} ±0.01	0.936 ^{ab} ±0.00
AS1	0.950 ^a ±0.02	0.941 ^{ab} ±0.01	0.940 ^a ±0.01

Means with different alphabet are statistically different ($P<0.05$)

Sample AS1 showed the highest A_w in the whole period of analysis. This product has been reported to be high in carbohydrate. Carbohydrate increases the water absorption of the dough and causes an increase in free water. During shelf life study, the samples showed reduced A_w caused as a result of water loss (Figure 4.4).

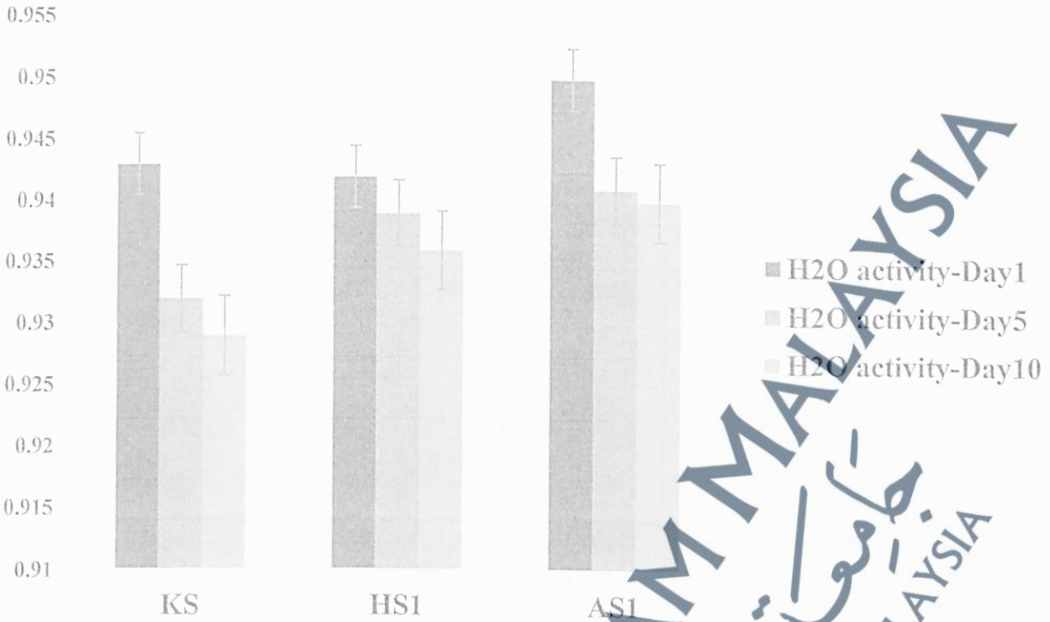


Figure 4.4: Water Activity of Bread Samples on Days 1, 5 and 10 after Baking

4.4.3 Sensory Characteristics

Sensory analysis is always needed to verify outcome of physical and chemical analysis in food. It is the ultimate test to determine market acceptability of product. Sensory scores of bread samples tested and the control are represented in Table 4.7 and individual sample score was depicted in Figure 4.5 to 4.7.

4.4.3.1 Sensory Analysis

Samples obtained similar score for aroma and overall acceptability. The appearance attribute score for samples KS and AS1 were not different and were higher than value obtained for the HS1. For colour attributes, sample AS1 was rated higher than the other samples. Both sample HS1 and AS1 had the same score for taste and texture attributes.

Generally all samples showed high score and well accepted, this is evidenced by the index of acceptability which show the least score to be 66.67%.

Table 4.7: Consumers Acceptability of Bread Samples

Sample	Appearance	Taste	Colour	Aroma	Texture	Overall	Acceptability Index (%)
KS	6.67 ^a ±0.58	6.67 ^a ±0.58	6.33 ^a ±0.58	6.00 ^a ±0.00	6.33 ^a ±0.58	6.00 ^a ±0.00	70.37
HS1	6.33 ^{ab} ±0.58	5.67 ^b ±0.58	6.33 ^a ±0.58	6.00 ^a ±0.00	5.67 ^{ab} ±0.58	6.00 ^a ±0.00	66.67
AS1	6.67 ^a ±0.58	5.67 ^b ±0.58	6.67 ^a ±0.58	6.00 ^a ±0.00	5.67 ^{ab} ±0.58	6.00 ^a ±0.00	67.93

Means with different alphabet are statistically different (P<0.05)

The acceptability index also revealed that acceptability of samples was in the order of KS>AS1>HS1. Higher acceptance score obtained by sample AS1 over HSI supports the finding of Selomulyo and Zhou (2007) that sensory properties benefit from the usage of improver.

The lowest rating for all samples was 58.67%. This showed that all samples were acceptable by the judges. The differences in both flour and improver were not sufficient to have a negative influence on consumer acceptability ratings.

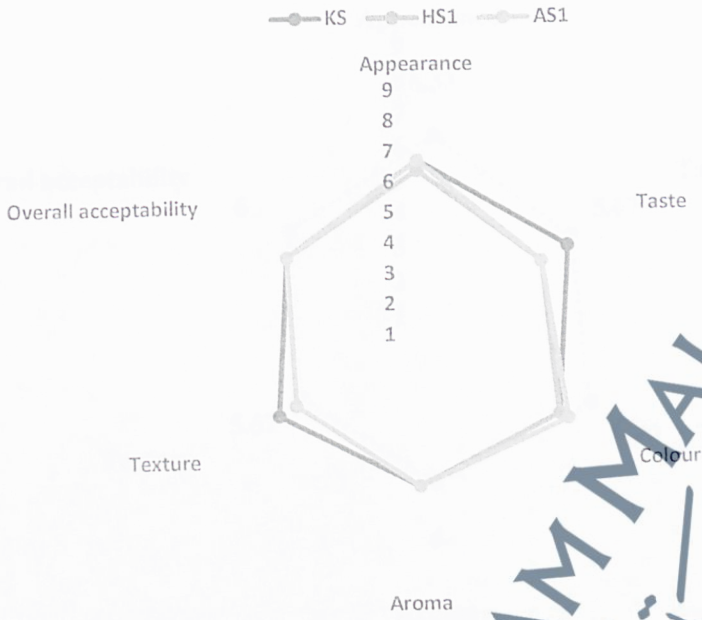


Figure 4.5: Organoleptic Analysis of Baked Bread Samples



Figure 4.6: Organoleptic analysis of the control baked bread sample (KS)

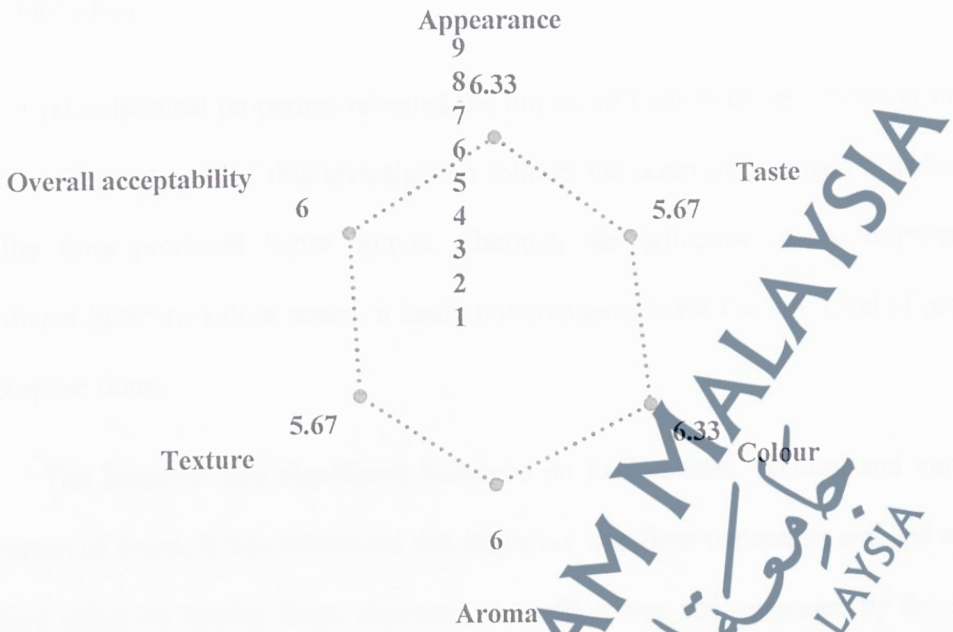


Figure 4.7: Organoleptic analysis of high gluten baked bread sample (HS1)



Figure 4.8: Organoleptic analysis of all-purpose baked bread sample (AS1)

4.5 Conclusion

The physicochemical properties revealed the impact of both flour and improver on bread features. The outcome of this investigation follows the norm of garbage in, garbage out. Quality flour produced better output. Although the influence of the improver was significant in the two flour tested, it could not compensate for the low level of protein in all-purpose flour.

The improver had significant influence on loaf volume, textural and nutritional properties of bread. It was evidenced that improver was flour dependent and had a higher positive effect on quality flour. However, this effect was not supported by the sensory outcome.