

CHAPTER III

EVALUATION OF FUNCTIONALITY OF THREE DIFFERENT BRANDS OF COMMERCIAL IMPROVERS ON WHITE BREAD CHARACTERISTICS

3.1 Introduction

Bread, though a permissible food require more investigation because of its complex and delicate production process. This is in agreement with the sayings of Allah, *"O believers! Save yourselves and families from a fire, whose fuel is men and stones; over it are angels stern and strong, they do not disobey Allah but do as they are commanded."* (Al-Quran. At-Tahrim 66:6). Allah said in another verse, *"Then eat of what Allah has provided for you [which is] lawful and good. And be grateful for the favour of Allah, if it is Him, you worship"* (Al-Quran. An-Nahl 16:114).

Bread is a common food that has been recognized globally for long for being a preferred fast food. It has become an ideal functional and staple food in various places (Umelo et al, 2014). It is consumed globally at all mealtimes by both adults and children. As demand trend of daily bread consumption increases, its producers need to focus on consumer satisfaction in order to keep the rising demand. However, bread quality is lowered considerably when improvers are omitted (Osuji, 2006; Umelo et al, 2014).

Therefore, the bakery industries must arm themselves with the technical knowhow to resolve the challenges associated with its physicochemical and sensory acceptance

(Ndife and Abbo, 2009; Selomulyo and Zhou, 2007). The baking potential of wheat flour is influenced by many factors including the type of wheat, protein content and wheat processing. For bread making to be of good quality, flour must be capable of forming a dough of satisfactory elasticity, strength and stability.

Bread improvers are combine with flour to improve baking functionality. Reported studies have shown that, bread improvers reinforce tolerance during the different manufacturing stages. They effect rheological, fermentative and proofing process. They make the process simple and seamless. Therefore, improve productivity, standardization and quality output (Selomulyo and Zhou, 2007). Improver has become an essential ingredient in bakery industries; it facilitates and speed processing time (Umelo et al, 2014).

More research is needed in this area if the satisfaction of both bakers and consumers are to be met. Consumers need good quality for acceptability while producer may aim to maximize profit (Shittu et al, 2007). Hence, there is a need for premium bread improver as a trade-off between the demand and supply chain. Many studies have been reported on bread production using chemical additives or enzyme as improver but no published research has studied the effect of commercial improver on bread production.

In a recent study, Umelo et al, (2014) presented ascorbic acid and eggs as alternative to potassium bromate (KB) in improvement of bread functionalities. The International Agency for Research on Cancer (IARC), 1986, 1999 established a link between KB and cancer thus in 1992 the Joint FAO/World Health Organization (WHO) Expert Committee on Food Additives in 1992 banned the use of KB as bread improver. Mouliney et al (2011)

conducted a study using wheat durum and fat as improvers of bread. They discovered that their impacts as improver are not the same. Another study by Ali and Halim (2013) used natural formulated improver consisting of enzymes and emulsifier to compensate for sesame flour characteristic in composite bread.

Many types of commercial bread improver exist in the market with differing quality performance based on the type of flour used. This study, therefore, is to determine the quality of bread in the presence of different brands of commercial improver, evaluate differences in their functionality and assess their impact on flour quality.

3.2 Materials and Methods

3.2.1 Baking Terminology

All-Purpose Flour: It is a blend of soft and hard wheat with a medium amount of gluten.

Autolyse: The rest period after a short initial period of mixing. Its purpose is to allow for passive gluten development, which minimizes the oxidation of the dough, as well as the development of enhanced enzyme activity to aid in the development of extensibility for shaping.

Baker's Percentage: This is an international language for bakers. It is a method of using numeric relationships to present a brief snapshot of the characteristics likely to be present in a dough or batter formula. It indicates the amount of each ingredient used as a percentage of the amount of flour used. Flour is the basis of baker's percentages because it is the main

ingredient in nearly all baked goods and assigned the value of 100%. The percentage of each ingredient is its total weight divided by the weight of the flour, multiplied by 100%.

Bread Flour: Flour made from hard wheat that has enough good-quality gluten for bread making.

Crumb: The soft internal portion of bread, surrounded by crust.

Crust: The external layer of bread surrounding the crumb.

Gluten: The major protein found in wheat flour that forms the structure of the bread and holds the carbon dioxide produced by yeast.

3.2.2 Raw Materials

Diamond brand high gluten flour and blue bicycle wheat flour (all-purpose) with protein content of 12.0 and 9.8% respectively were the two types of flour selected for this study, YNS, Nona and Kijang were the commercial improvers under test, other ingredients include baker's yeast, salt and sugar.

All materials were supplied by Food Biotechnology Department, Universiti Sains Islam, Malaysia (USIM). Nona described by manufacturer as conditioner powder and dough softener was made from corn starch and salt, Kijang from wheat flour, mineral salts, emulsifiers, starch, flavour treating agent and enzymes while YNS was not specified.

Table 3.1: The Commercial Improvers and Their Ingredients

Improver	Ingredients					
Kijang-Brand 1	Starch	Mineral salt	Enzymes	Emulsifier	Flavour agent	treating
Nona-Brand 2	Corn starch	Mineral salt	-	-	-	
YNS-Brand 3	Not specified					

For each flour type, there were four treatments, treatment (T) A – D and 1-4 for high and all- purpose flour type respectively. Treatments A and 1 are the control samples for the two flour types accordingly. Samples B, C and D are high gluten samples with the first brand, second brand and third brand of improver respectively. Samples 2, 3 and 4 representing all-purpose samples with the first brand, second brand and third brand of improver accordingly.

3.2.3 Determination of Percentage Gluten in Flour

Manual gluten washing was employed to determine the amount of gluten present in each flour.

Water (60% flour weight) was mixed with flour to form a stiff ball of dough, the dough was wrapped with muslin cloth and its starch was washed out under running water until cleaned and cleared water drained out from the cloth.

The obtained gluten (cream coloured particles) was made into ball and weighed then baked on pieces of foil in ovens preheated to 200 °C for 30 minutes the volume and weight of the gluten ball was taken upon cooling. Ball like structures obtained quantified the amount of gluten present in each flour and their cell structures indicated that both flour

are of good quality. The wet gluten was then quantify as a mass fraction of flour (AACC, 2010).

The percentage gluten is calculated as follows:

$$\% \text{gluten} = \frac{\text{weight of gluten}}{\text{weight of original flour}} \times 100$$

(2)

3.2.4 Baking Procedure

The baking recipe for each sample of this study in baker’s percentage in proportion of flour was 100% flour, 2.25% salt, 60% water, 3.75% instant dry yeast, 3.75% sugar and 1.0% improver based on manufacturer recommendation. The flour was baked into bread using the Straight dough method.

Table 3.2: Bread Recipe and Quantity

Ingredient	Baker’s percentage (%)
Flour	100.00
Salt	2.25
Water	60.00
Instant dry yeast	3.75
Sugar	3.75
Improver	1.00

After weighing, ingredients were dried mixed for 5 minutes in a Kitchen Aid mixer (Kitchen Aid-KSM 900, USA) at low speed before water mixed and check for window test. Dough was transferred to proofer at 30 °C, and 70% relative humidity until it doubled in size, kneading was done manually and the kneaded dough was transferred into baking pans greased with fat and returned to proofer for second proofing before transferring into oven.

Baking was done for 30 minutes at the temperature of 200 °C. The bread was allowed to cool for a minimum of two hours before further analysis.

3.3 Baking Properties

3.3.1 Loaf Volume and Weight

Bread characteristics were evaluated by measuring the loaf weight, loaf volume and specific loaf volume (SV). Loaf weight was measured after cooling to room temperature using a weighing balance. Loaf volume was measured using rapeseed displacement method (AACC 2010).

Rapeseed grains were loaded into an empty box with calibrated mark until it reached the marked level and unloaded back. The bread sample was put into the box and the measured rapeseed was loaded back again. The remaining rapeseed grains left outside the box was measured using measuring cylinder and recorded as loaf volume in cm³. The specific loaf volume was determined by dividing the loaf volume by its corresponding loaf weight (A-Saleh and Brennan, 2012).

3.3.1.1 The Specific Volume

The specific volume of the loaf was calculated using the following equation:

$$S.V \text{ (cm}^3\text{/g)} = \frac{\text{Loaf volume}}{\text{loaf weight}} \quad (3)$$

3.3.1.2 Bread Density

The density was calculated as the ratio of the weight to volume.

$$\text{Bread density} = \frac{\text{weight of bread}}{\text{volume of bread}} \quad (4)$$

3.3.1.3 Loaf Height

The loaf height was measured using measuring ruler. The reading was taken from the top to the bottom of the loaf at three different sides (left, middle, and right). The average of the three points was recorded.

$$\text{Average height (H}_A\text{)} = \frac{H_1 + H_2 + H_3}{3} \quad (5)$$

3.3.1.4 Average Weight Loss

The dough and the baked loaf were weighed, and the percent weight loss was calculated as:

$$\% \text{weight loss} = \frac{\text{weight of dough} - \text{weight of baked bread}}{\text{weight of dough}} \times 100 \quad (6)$$

3.3.2 Crumb and Crust Colour

The tristimulus colour parameter of crumb and crust was measured with Hunterlab Lab scan XE colourimeter. The results were reported as L* (lightness), a* (redness and greenness), and b* (yellowness and blueness). The measurements were made in triplicate and the means and standard deviations were reported. Slices from the center of each bread

were scanned with a scanner (Canon Scan Lide 700F, Canon) as described by Skendi et al. (2010) to obtain digital image of the crumbs.

3.3.3 Texture Analysis

Crumb texture profile analysis was performed using a TA.XT^{plus} TA XT Express texture analyzer (Stable Micro Systems Ltd., Surrey, UK) according to the AACC (2010) approved method. Firmness testing was performed on bread loaves that were stored for five days. About 25 mm thickness sliced crumb samples were cut from the center of each loaf using a kitchen knife, samples were analyzed immediately after extracting to prevent excess moisture loss.

Samples were compressed in dual cycle using a 36 mm cylinder probe with the maximum compression of 40% at a crosshead speed of 1.7 mm/s. The analysis was performed in triplicate for each treatment and average values were reported.

3.3.4 Moisture Analysis

The moisture content of bread was estimated by the moisture analyzer (AND method). About five g samples was used at 160 °C. Triplicate measurements were done and values were reported as means along with standard deviations.

3.3.5 Statistical Analysis

The results obtained were reported as the means of three loaf replicates. Analysis of variance (ANOVA) was used to compare the result using Minitab 16 software. Significant

differences between the mean values were determined using Tukey’s test at a significance level of $P < 0.05$. All determinations were performed in triplicate.

3.4 Results and Discussion

3.4.1. Gluten Content Determination

Gluten quantity of flour is a good indicator of measuring flour quality. The amount of protein in flour is directly related to the amount of gluten produced (Campbell et al, 2012). Hence, there are different types of flour with varying quality. Hard flours with high protein contents (14% protein) have a roughly estimate wet gluten of 35-38% while soft flour ranges from 24-28% (AACC, 2010).

The ball like structure obtained quantified the amount of gluten present in each flour and their cell structure were representative of their quality. The result confirmed both flour to be of high quality. The percent gluten and gluten structure are presented in Table 3.3 and Figure 3.1 respectively.

Table 3.3: Gluten Composition of Flour

Flour type	Wet gluten (%)	Dry gluten (%)
High gluten	38.20 ^a ±0.08	28.00 ^a ±2.00
All-purpose	27.27 ^b ±2.00	14.07 ^b ±2.00

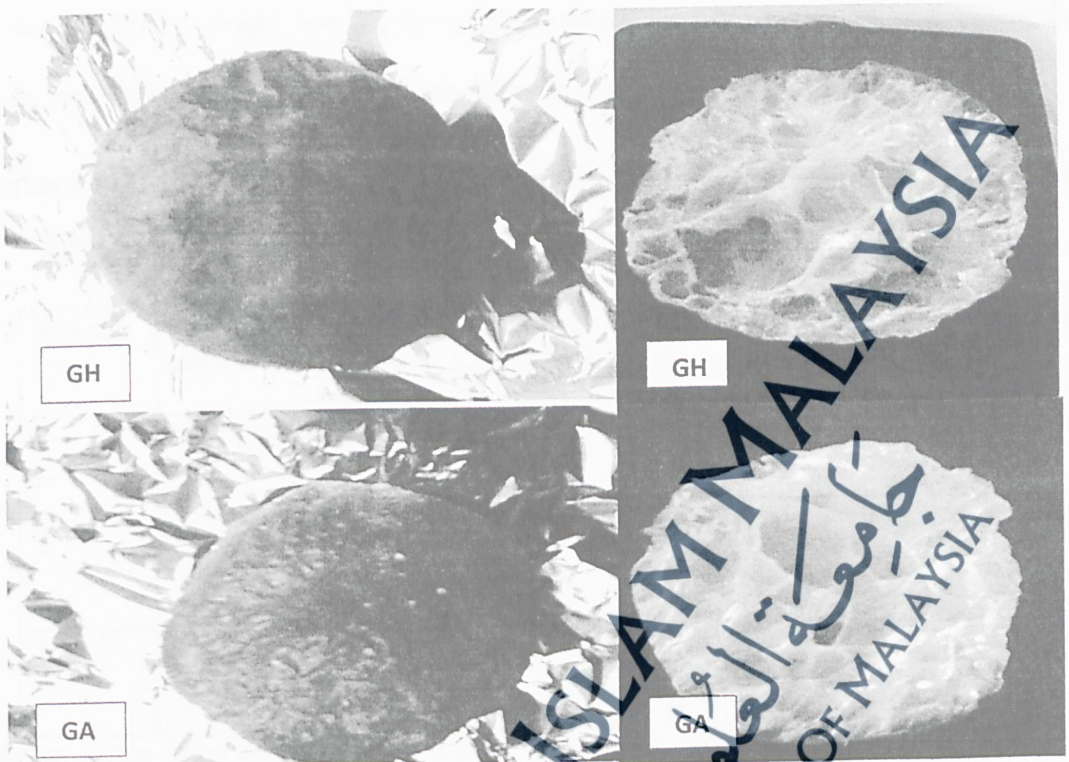


Figure 3.1: Gluten ball and structure for High Protein Flour (GH) and All-Purpose Flour (GA)

3.4.2 Physicochemical Characterization of Bread

The average volume, specific volume, density, weight, loaf weight loss and loaf height of the bread samples from all-purpose and high gluten flour are presented in Table 3.4 and 3.5 respectively. For All-purpose samples, sample 1 obtained the highest value for weight, density and loaf height. It also had the lowest value of percent weight loss implying that it had higher moisture retention compared to other samples.

Sample 2 had the lowest value for both volume and weight. Volume and specific volume of sample 3 were higher compared to the other two samples and had the highest

value of percent weight loss implying that it could not retain moisture well like other samples. This will have direct negative effect on texture and crumb structure of sample.

Table 3.4: Loaf Volume, Specific Volume, Density, Weight, Loaf Height, and Percentage Weight Loss of All-Purpose Sample Produced with Different Improvers

Sample	Volume (cm ³)	Specific volume (cm ³ /g)	Density (g/cm ³)	Weight (g)	Loaf height (cm)	% weight loss (%)
1	430.94±1.50 ^b	0.85±0 ^c	1.17±0.01 ^a	506.70±5.09 ^a	8.64±0.20 ^a	10.56±0.20 ^c
2	421.19±1.36 ^c	0.89±0.01 ^b	1.14±0.01 ^b	477.70±1.27 ^c	8.52±0.20 ^b	14.3±1.58 ^a
3	446.81±3.51 ^a	0.9±0.01 ^a	1.13±0.01 ^b	501.35±0.92 ^b	8.11±0.16 ^c	14.32±1.58 ^b

Means in the same column with the same superscript are not significantly different at (P>0.05).

Sample 1= bread + Kijang improver; **Sample 2**= bread + Nona improver; **Sample 3**= bread+ YTS improver

Bread sample prepared from High gluten flour showed no significant difference for weight and loaf height. Sample A had the highest volume, lowest density and percent weight loss. Sample B obtained the lowest value for volume, specific volume and highest percent weight loss. Sample C had the highest specific volume, an important indicator of bread quality (Yi et al, 2009).

The obtained result suggests that sample A and sample C showed better result when compared with sample B. However, highest volume exhibited by sample A with greater

moisture retention as indicated by its lowest percent weight loss adds value to the sample. Greater moisture retention creates better crumb structure. Shittu et al, 2007 explained that volume is a consumer judging characteristic, higher volume loaf gains more value and justified for price paid.

Table 3.5: Loaf Volume, Specific Volume, Density, Weight, Loaf Height, and Percentage Weight Loss of High Gluten Samples Produced with Different Improvers

Sample	Volume (cm ³)	Specific volume (cm ³ /g)	Density (g/ cm ³)	Weight (g)	Loaf height (cm)	% weight loss (%)
A	550.65±2.05 ^a	1.03±0 ^b	0.97±0 ^c	535.50±3.54 ^a	9.17±0.23 ^a	7.29±1.99 ^c
B	407.11±4.26 ^c	0.78±0.03 ^c	1.28±0.04 ^a	520.30±9.33 ^a	8.95±0.07 ^a	9.23±0.10 ^a
C	502.69±2.42 ^b	0.96±0.01 ^a	1.05±0 ^b	527.00±1.41 ^a	8.65±0.33 ^a	8.74±0.01 ^b

Means in the same column with the same superscript are not significantly different at (P>0.05).

Sample A= bread + Kijang improver; **Sample B**= bread + Nona improver; **Sample C**= bread+ YTS improver

Comparing the two flour types, samples from high gluten flour produced greater loaf volume, weight and height compare to all-purpose samples. Loaf volume is associated to the quantity and quality of protein in the flour used for baking (Shittu et al, 2007). Higher loaf volume of bread creates a less dense, optimally developed and functional gluten structure (Umelo et al, 2014). This leads to better crumb resilience and moisture retention, and therefore, a softer crumb (Umelo et al, 2014; Yi et al, 2009).

In the two flour samples, samples with the second brand of improver showed little effect compared with others. Samples with the third brand of improver showed better

performance but of less quality to samples with the first brand of improver. This implies that the improvers efficiency on flour was on the order of first brand > third brand > second brand. It was observed that improver impact greater height in bread but in a reversed order as sample 3 gained more height than sample 4 while sample B recorded highest height. This confirms the findings of Mouliney et al (2011) on wheat durum and fat as improvers of bread. They revealed that their impacts as improver are different.

Specific volume is an important parameter as it is associated with dough inflating ability and oven spring and extremes in its values affect crumb structure ((Scanlon and Zghal, 2001; Yi and others 2009). Higher specific values obtained in all samples with improver compared with the controls. Sample B recorded the highest values in high gluten while sample 4 scored best in all-purpose flour however, there is no significant difference in brand B improver in the two flour tested.

Bread with high density is low in volume with less visible air pockets due to the compact crumb structure resulting in reduced weight of the bread as transformation proceeded (Scanlon and Zghal, 2001; Therdthai et al, 2002). Smaller values of specific density as observed in the first sample are associated with compact, dense and closed grain structure while larger values indicate open grain airy structures (Sharadanant and Khan 2003).

Density gives an indication of the size and ratio of air cells to solid product while the percentage weight loss is associated with the loss of moisture and entrapped CO₂ from the dough matrix (Ndife et al, 2013). Therdthai et al. (2002) confirmed that weight loss

during baking to be due to water evaporation in the outermost layer of dough because of formation of the crust.

3.4.3 Crust and Crumb Colour L*, a* and b* Values of Bread

Crust colour is a good indication of bread quality especially by the consumers. It is associated to chemical reactions including Maillard reaction and caramelisation during baking (Dimuzio, 2010; Nielsen, 2010; Therdthai et al, 2002). Colour characteristic of bread prepared from both flour using the three improvers evidenced a satisfactory development of crumb and crust of samples.

Table 3.6: Crust and Crumb Colour L*, a*, b* Values of All-Purpose Bread Samples

Sample	CRUST			CRUMB		
	L*	a*	b*	L*	a*	b*
1	69.36±0.94 ^d	7.02±0.71 ^d	27.10±0.9 ^{0^c}	76.63±0.2 ^{3^a}	0.49±0.11 ^f	18.4±0.1 ^{5^{ef}}
2	63.45±0.04 ^e	12.03±0.01 ^b	32.66±0.4 ^{4^a}	74.37±0.2 ^{6^{ab}}	0.83±0.01 ^e	17.46±0.07 ^f
3	57.0±1.18 ^f	10.64±0.03 ^c	29.29±0.1 ^{4^b}	72.23±1.3 ^{2^{bc}}	1.66±0.06 ^e	20.90±0.40 ^d

Means in the same column with the same superscript are not significantly different at (P>0.05).

According to Table 3.6, addition of improver increase the L* values of both crust and crumb in all samples from all-purpose types, the greater the L* value, the lighter the colour. There was no significant difference in the brightness among samples of high gluten

flour. ANOVA showed significantly differences in the L*, a*, and b* values for the crusts of bread samples made from all-purpose flour.

Variability in the improvers resulted in an increased in the lightness (L*) and reduction in the redness (a*) of High gluten samples. Less significant changes were found in the lightness component (L*) of produce from high gluten (Table 3.7), while redness (a*) and yellowness (b*) values of the crust were significantly different in all samples.

Modifications in the crust colour increased drastically in the all-purpose flour samples. Therdthai et al, (2002) recommended an average crust value of white bread as 54 to 62 (L* value). The result of this finding is in consistent with this range.

Table 3.7: Crust and Crumb Colour L*, a*, b* Values of High Gluten Bread Samples

Sample	CRUST			CRUMB		
	L*	a*	b*	L*	a*	b*
A	58.78±0.30 ^b	8.7±0.42 ^b	22.78±0.7 ^{6^b}	70.49±0.8 ^a	1.41±0.19 ^c	18.57±0.5 ^{7^d}
B	56.25±0.76 ^b	8.42±1.20 ^b	21.33±0.9 ^{1^{bc}}	70.17±0.4 ^a	1.54±0.04 ^c	19.49±0.2 ^{9^{cd}}
C	57.0±1.18 ^b	10.99±0.7 ^{6^a}	27.33±0.2 ^{6^b}	70.02±1.9 ^{9^a}	1.05±0.18 ^c	18.51±0.1 ^{8^d}

Means in the same column with the same superscript are not significantly different at (P>0.05).

3.4.4 Bread Firmness

Texture analysis is an objective physical examination of baked products and gives direct information on the product quality. Improver addition enhanced bread specific volume, improved bread appearance, and textural properties of bread. Crumb firming is one of the

most obvious and important manifestations of bread staling. Bread with and without improver were analyzed to assess bread qualities. The firmness values of bread are presented in Table 3.8 and 3.9. The result obtained indicated that there is no statistical difference among all samples ($p>0.05$).

Table 3.8: Firmness of All-Purpose Bread Samples

Treatment	Firmness (g)
1	610.26±5.25 ^a
2	515.49±127.12 ^a
3	731.40±115.72 ^a

Means in the same column with the same superscript are not significantly different at ($P>0.05$).

The mechanism of crumb-firming has been linked to the transfer of moisture between gluten and starch as part of the overall staling process (Oliveira et al, 2014), however, it is impossible to relate firmness observed in this study to staling since the initial softness of the bread was not quantify and firmness during different storage days was not assessed because the firmness value by itself cannot be translated into a freshness rating.

Table 3.9: Firmness of High Gluten Bread Samples

Treatment	Firmness (g)
A	486.44±19.69 ^a
B	488.28±80.04 ^a
C	470.31±4.09 ^a

Means in the same column with the same superscript are not significantly different at ($P>0.05$).

Texture is the absence of flaws, in the quality of food produce. Textural properties of foods are identified by consumers as vital quality indicators that contribute to product acceptability (Selomulyo and Zhou, 2007; Upadhyay et al, 2012). Compression tests have been employed to assess textural property of bread (Nielsen, 2010).

The knowledge of textural characteristics of food is essential in ensuring product quality that can display satisfactory quality to consumers. Based on knowledge of product mechanical properties, it is possible to predict the perceived texture of a food from the interaction between its mechanical properties and the processing conditions within the mouth (Upadhyay et al, 2012).

3.4.5 Moisture Content (percentage) Values of Bread Crumb

Moisture content of food is an indicator of the quality of the product and has a potential impact on the sensory, physical and microbial properties of bread in particular (Ndife et al, 2013). The moisture content of the bread samples made from different dough improvers were (all-purpose) 34.86, 36.83, 34.44 and 36.87, 37.54 and 36.40 (high gluten) for treatments 1 to 3 (Table 3.10) and treatments A to C (Table 3.11) accordingly.

Table 3.10: Moisture Content of Samples from All-Purpose Flour

Samples	Moisture content (%)
1	34.86±0.18 ^b
2	36.83±0.41 ^a
3	34.44±0.11 ^c

Means in the same column with the same superscript are not significantly different at (P>0.05).

Higher values of moisture content were obtained from high gluten samples compared to all-purpose samples ($P<0.05$) though all samples' values were within the mean value of bread moisture content of 36.65%. This result on moisture content is not different to those reported in literature (Mandala and others 2007; Ndife et al, 2013). Lawrence and Adewumi (2012) reported in their study that moisture content within the average of 36% is an indication that the products will likely have good stability, which will extend their shelf life.

Table 3.11: Moisture Content of Samples from High Gluten Flour

Samples	Moisture content (%)
A	36.87±0.41 ^b
B	37.54±0.76 ^a
C	36.40±0.38 ^c

Means in the same column with the same superscript are not significantly different at ($P>0.05$).

Higher moisture content as long as it is in the acceptable range as observed in high gluten products has been reported to have positive effect on loaf volumes of bread (Gallagher and others 2005).

3.5 Discussion

Comparing the samples, all the brands of improvers increased specific volume and loaf height of treated samples. The good performance of the improvers in both flour is consistent with the study by Umelo et al. (2014) who found that, bread produced with dough improver

have good physical and sensory attributes like poor volume, taste, flavour, crust colour, crumb texture and crust texture (Umelo et al, 2014).

Brand A improver had contradictory performances in different flour nevertheless was the most effective. In the high gluten flour, it produced the highest specific volume. In all-purpose flour, it experienced a significant lower volume compared to the third brand of the improvers. This could not be explained due to lack of information on this third brand component. Like all other research done on bread improvers, the range recommended by suppliers was used as a guide and all improvers were treated in the same way.

Brown crust in bread is a result of non-enzymatic browning reaction between amino acids and reducing sugars ((Dimuzio, 2010). Unlike α -amylase, which produces more sugar in the dough, resulting in crust darkness increase, the improvers do not change the carbohydrate profile of the dough: hence the unchanged crust colour.

Crumb colour is related to flour type and to crumb air cell structure which affect the way that light reflects from a piece of bread. There is no significant difference in bread samples from high gluten flour while increase in lightness observed as improver substitution occurring in all-purpose flour.

The functionality of bread improver differs, depending on flour types and processing. Therefore, application of the test improvers to a particular flour requires further baking trials. Further studies with sensory test panel are needed to quantify differences in characteristics.

3.6 Conclusion

This study showed that acceptable bread could be produced from both all-purpose and high gluten flour using any of the three commercial improvers with brand A and C giving better results in the physicochemical characteristics of the bread. They produced bread samples with higher volume, better crust and crumb colour, with acceptable crumb and crust texture.

Since brand C was not labelled, its component could not be ascertained. However, it is impact, especially on all-purpose flour suggested it is probably contain some emulsifier, enzyme amylase that work on starch component of flour and or materials that added protein to the gluten content of the flour.

The overriding effect of the first and third brand of improvers over the second brand of improver could be traced to the presence of salt and lack of enzymes in the brand formulation. High water-binding capacity of salt was reported to impact negatively on dough formation and bread quality (Mohamed et al., 2010). Mohamed et al, (2010) avoided the use of both sugar and salt in preparation of yeast-leavened banana because of high sugar content of banana powder employed. This suggests modification of recipe if the second brand of improver is to be used.

When comparing the effects of the three improvers on the bread characteristics such as, crust, crumb colour, texture and specific volume, the third brand of improver was the most effective in all-purpose flour however, the first brand improver resulted in overall best in the two flour tested. It was observed that the three improvers differ in their ability to effect flour. The type or composition of improver that one uses to improve bread is, therefore, of utmost importance.

In conclusion, the significant differences in the characteristic of bread samples indicate differences in the composition of improvers. The choice of improver is therefore very important in respect of flour type. It could be speculated from the results that though brand C improver can be employed in all-purpose flour, brand A is the most suitable for both high gluten and all-purpose flour.

