



## Percentage Composition of Edlen Dough Conditioner (Edc) and Carboxymethylcellulose (Cmc) on Bread Production

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### Abstract

The use of dough improvers as an ingredient in bread production and their effects on bread quality was studied. Edlen Dough Conditioner (EDC) and Carboxymethylcellulose (CMC) were included as ingredients in bread production. Eight loaves of bread samples were baked, four made from higher gluten flour and the rest from lower gluten flour. The control samples were baked without addition of EDC and CMC. The other loaves were baked with EDC / CMC combined at different levels (0.4% / 1.0%), (1.0% / 0.2%) and (0.8 % / 0.8%). The proximate composition of the flour and bread samples was evaluated as well as physical property and sensory evaluation. The proximate composition of flour samples was similar whereas bread samples were ranged from 31.20 - 34.47 % (moisture); 8.60 – 8.86 % (crude protein); 1.65 – 1.87 % (ash); 1.13 – 1.38 % (crude fibre); 3.19 – 3.72 % (crude fat); 49.94 – 54.40 % (total carbohydrate) and 267.93 – 280.74Kcal/100g (energy). Significant differences ( $p < 0.05$ ) exist in the loaf volumes, weights, and specific volumes with the bread sample made with 0.2 % EDC / 1.0 % CMC having the highest specific volume of 5.80cm<sup>3</sup>/g. Also, there were significant differences ( $p < 0.05$ ) in the crust color, crumb texture, mouthfeel, shape of the loaves, and overall acceptability of the bread samples. The research study encouraged the use of EDC and CMC in bread production.

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### Introduction

Cereal food products, especially bread have become very popular in Nigeria among children and adolescents (Anyika and Uwaegbute, 2005). Bread consumption has increased tremendously in recent times in developing countries, where it is consumed in every household. It is a common food which is sold in the markets, motor parks, shops, and even supermarkets. The introduction of 10 % cassava flour in wheat flour in Nigeria by the Nigerian Government since 2004 has been a challenge to the flour millers and bakers which lead to the collapse of dough in the oven, heaviness and smelling of bread after few days. Bakers have tried other methods including the use of bromate and the mixture of more than one brand of flour. However, the ban on the use of bromate has contributed to the introduction of the following emulsifier such as Edlen dough Conditioner (EDC) and hydrocolloids such as Carboxymethylcellulose (CMC), egg among others. EDC 95, EDC 2000 and baker bite has been in use by master bakers but research about them and the percentage of their usage

is sparse. However, use of additives such as emulsifiers and hydrocolloids has become a common practice in baking industry. Emulsifiers are commonly added to commercial bakery products to improve the bread quality and dough handling characteristics (Kohajdova *et al.*, 2009). Some frequently used emulsifiers are diacetyl tartaric acid esters of mono-diglycerides and lecithin, which are known as dough improvers and monoacylglycerols which are applied as antistaling agents or crumb softeners. Hydrocolloids are one of the most extensively used additives in the food industry (Selomulyo and Zhou, 2007). The term hydrocolloids embrace all many polysaccharides that are extracted from the plant, seaweeds and microbial sources, as well as gums derived from plant, and modified biopolymers made by the chemical treatment of cellulose (Dickinson, 2003). Food hydrocolloids such as Carboxymethylcellulose (CMC), hydroxypropylmethylcellulose and alginate are high-molecular-weight hydrophilic biopolymers use as functional ingredients in the food industry. Hydrocolloids have been used for

retarding staling and improving the quality of the fresh product (Kohajdova *et al.*, 2009). To make quality and toxic-free bread, the knowledge of hydrocolloids composition and chemistry is greatly important. Therefore, this work aims to determine the effect of EDC (emulsifier) and CMC (hydrocolloids) on bread quality and optimal acceptability.

### Materials and Methods

The commercial wheat flour (high and low gluten contents, Golden Penny brand) was purchased from Agbeni Market Ibadan, Ibadan South West Local

Sample 1 = EDC (0.0%) and CMC (0.0%) Control  
Sample 2 = EDC (0.4%) and CMC (1.0%)  
Sample 3 = EDC (1.0%) and CMC (0.2%)  
Sample 4 = EDC (0.8%) and CMC (0.8%)

} With higher gluten wheat flour

Sample 5 = EDC (0.0%) and CMC (0.0%) Control  
Sample 6 = EDC (0.4%) and CMC (1.0%)  
Sample 7 = EDC (1.0%) and CMC (0.2%)  
Sample 8 = EDC (0.8%) and CMC (0.8%)

} With lower gluten wheat flour

### Bread Making Procedure

The method of Ihekoronye (1999) was adopted and modified for bread production. The ingredients were weighed into eight portions using an electronic weighing balance. Each of flour sample (5kg) was mixed with other ingredients as shown in Table 1. The mixing was done via a mixer and with aid of the kneading machine; the dough was kneaded until it formed smooth elastic and non-sticky dough, and

Government, Oyo State, Nigeria. The emulsifiers (Edlen dough conditioner) and hydrocolloids (carboxymethylcellulose) were purchased from Aleshinloye Market, Ibadan.

The method of Mettler and Seibel (1993) was adopted and modified. The flour with other ingredients such as yeast, salt and sugar were mixed in dry form excluding water. Varying combination of EDC and CMC were added to the mixture, thereafter water. Eight samples of bread were produced and labeled accordingly as shown below.

divided, moulded into its final shape and then put in an oiled baking pan. Dough in an oiled pan were allowed to proof for 4 h and baked in an oven at 220 °C for 30 minutes till golden brown colours achieved. The bread samples were depanned, cooled at room temperature, packaged in a polyethylene bags for further analysis. The numbers of loaves of bread obtained per 5kg flour sample as well as the left over were recorded.

Table 1: The Recipe of Bread Samples Produced

Samples	Flour (kg)	Salt (g)	Yeast (g)	Sugar (g)	Water (%)	EDC(g)	CMC(g)
GPF1	5.0	45.0	30.0	300.0	50.0	0.0	0.0
GPF2	5.0	45.0	30.0	300.0	60.0	20.0	50.0
GPF3	5.0	45.0	30.0	300.0	55.0	50.0	10.0
GPF4	5.0	45.0	30.0	300.0	52.0	40.0	40.0
GPCF1	5.0	45.0	30.0	300.0	50.0	0.0	0.0
GPCF2	5.0	45.0	30.0	300.0	50.0	20.0	50.0
GPCF3	5.0	45.0	30.0	300.0	50.0	50.0	10.0
GPCF4	5.0	45.0	30.0	300.0	50.0	40.0	40.0

Source: Mettler and Seibel (1993).

NOTE: GPF – Higher gluten wheat flour

GPF1= Bread made from GPF without EDC and CMC; GPF2 = Bread made from GPF with EDC (0.4%) and CMC (1.0%); GPF3 = Bread made from GPF with EDC (1.0%) and CMC (0.2%); GPF4 = Bread made from GPF with EDC (0.8%) and CMC (0.8%).

GPCF – lower gluten wheat flour; GPCF1 = Bread made from GPCF without EDC and CMC; GPCF2 = Bread made from GPCF with EDC (0.4%) and CMC (1.0%); GPCF3 = Bread made from GPCF with EDC (1.0%) and CMC (0.2%); GPCF4 = Bread made from GPCF with EDC (0.8%) and CMC (0.8%).;EDC = Edlen Dough Conditioner. CMC = Carboxymethylcellulose.

### Chemical Analysis:

#### Proximate Analysis of the Flour and Bread Samples

The moisture, protein, ash, fat and crude fibre content of the flour and bread was determined using the method of Bradley (2003). Carbohydrate was calculated by difference (%).

**Energy Content :** The gross energy of the samples was determined by calculation using Atwater's conversion factor ( $4 \times \text{Protein} + 9 \times \text{Fat} + 4 \times \text{Carbohydrate}$ ) %. The sum of these values was expressed in kcal/100g sample (Onyeike *et al.*, 2000).

#### Physical Property of Bread Samples

Physical properties of the bread samples were determined by measuring the loaf volume, loaf weight, specific loaf volume, dough yield (number of loaves obtained) and leftover. Loaf weight was measured with a Camry digital scale; bread volume was determined using text volume analyzer (text volume analyzer makes use of laser technology to determine the volume). A laser beam moves in a circle around the rotating loaf and the volume of the bread was taken by a special devised computer program. The text volume analyzer determines the correct volume and other physical attributes of the bread. The specific volume was determined by dividing the loaf volume by its corresponding loaf weight and the value was presented in  $\text{cm}^3/\text{g}$  (Araki *et al.*, 2009)

#### Sensory Evaluation

Sensory evaluation was conducted on the bread samples using the method of Iwe (2002). The bread samples were evaluated for crust colour, crumb texture, flavor/mouth feel, shape of the loaf and overall acceptability. Panels of 40 selected bakers were randomly selected and samples were rated on a 9-point hedonic scale where 1 represented Dislike Extremely and 9-Like extremely.

### Results and Discussion

#### Proximate Composition of the Flour Samples

The data on the proximate composition of the flour samples (higher gluten and lower gluten wheat flours) are shown in Table 2. There were no noticeable differences ( $p > 0.05$ ) in the moisture and fat contents of the flour samples but significant differences existed in the crude protein, ash, crude fibre, carbohydrate and energy contents of the flour samples. Sample GPF (higher gluten wheat flour) has higher protein content (11.20%) than sample GPCF (lower gluten wheat flour) which has a protein content of 10.03%. The

results were similar to the results reported on literature (Weiss, 2000; Potter and Hotchkiss, 2006). The chemical composition of the flours has been reported to affect both physicochemical properties and nutritional quality of their product (Dhingra and Jood, 2001; Akhtar *et al.*, 2008; Mashayekh *et al.*, 2008).

Table 2: Proximate Composition of Flour Samples

Proximate Composition	GPF	GPCF
Moisture (%)	14.00±0.11 <sup>a</sup>	14.00±0.01 <sup>a</sup>
Crude Protein (%)	11.20±0.03 <sup>a</sup>	10.03±0.03 <sup>b</sup>
Ash (%)	0.74±0.04 <sup>a</sup>	0.50±0.02 <sup>b</sup>
Crude Fibre (%)	0.81±0.01 <sup>a</sup>	0.65±0.02 <sup>a</sup>
Crude Fat (%)	0.98±0.02 <sup>a</sup>	0.97±0.01 <sup>a</sup>
Carbohydrate (%)	72.33±0.02 <sup>b</sup>	73.84±0.04 <sup>a</sup>
Energy (Kcal/100g)	342.91±0.15 <sup>b</sup>	344.24±0.04 <sup>a</sup>

Values are the mean of the samples  $\pm$  standard deviation of the triplicates. Values with different superscript along the same row are significantly different ( $p < 0.05$ ).

GPF = Golden Penny Flour (Higher gluten wheat flour).

GPCF = Golden Penny Confectionary Flour (Lower gluten wheat flour).

#### Proximate Composition of the Bread Samples

The result of the proximate composition of the bread samples showed that there were significant differences ( $p < 0.05$ ) in all the proximate compositions of the bread samples evaluated (Table 3). The addition of the bread improvers such as Edlen dough conditioner (EDC) and Carboxymethylcellulose (CMC) on the bread dough greatly affected the proximate composition of the bread samples. The moisture content of the bread was in the range 31.11 – 34.49%. There was no significant difference ( $p > 0.05$ ) between the moisture content of samples GPF2, CGF3 and GPF4 being the bread that composes of 0 – 1.0% EDC and CMC, with sample CGF2 having the highest moisture content of 34.49%.

The high moisture content could be attributable to the high moisture absorbed by the flour (higher gluten wheat flour) used. The bread samples without EDC and CMC had moisture contents of 31.20% and 31.11% for higher wheat flour and lower gluten wheat

flour respectively. These values were slightly lower to the value (36.13%) for moisture contents of the bread sample reported by (Onuegbu *et al.*, 2007). The differences in percentage moisture contents of the bread could be attributable to the degrees of exposure of heat which led to the moisture evaporation during baking. High moisture content has been associated with the short shelf life of the bread as they encourage microbial proliferation that lead to spoilage (Ezeama, 2007). The bread samples had similar protein contents (8.60 – 8.86%). The protein content of higher gluten wheat flour bread under study (8.60%) is slightly higher to the value (8.13%) reported for the protein content of whole wheat bread by (Ndife *et al.*, 2011). The ash content of the bread samples ranged from 1.56 – 1.87%. The low ash content of the bread sample could be as a result of the low ash content of the flour samples (0.74 and 0.50%) as shown in (Table 1). Therefore, bread should be consumed with other food sources rich in minerals to balance the nutrients. Similarly, values of the crude fibre contents of bread samples were ranged from 1.13 – 1.38%. These values of crude fibre in bread samples under study were lower to 3.30 % for wheat bread reported by (Ndife *et al.*, 2011). The crude fibre contents of these bread samples were within the recommended range of not more than 6 g dietary fibre and other non-absorbable carbohydrates per 100g dry matter (FAO/WHO, 1994). The higher fibre content of bread has several health benefits, as it aids in the digestion of bread in column and reduce constipation often associated with bread produced from refined wheat flour (Jideani and Onwubali, 2009; Elleuch *et al.* 2011). Dietary fibre plays a significant role in the prevention of several diseases such as cardiovascular diseases, constipation, irritable colon and diabetes (Slavin, 2005; Elleuch *et al.*, 2011).

For the percentage of crude fat contents in bread samples, the bread had similar contents of 3.19 – 3.72 %. The high oil content of bread will affect the shelf stability (Weiss, 2000; Potter and Hotchkiss, 2000).

The carbohydrate and energy contents of bread samples followed the same trend. The carbohydrate content ranged from 49.94 – 54.40 % whereas the energy values were 267.57 – 280.74Kcal/100g. The low carbohydrate content observed in this study could be attributed to the low-fat contents (3.19 – 3.72 %) of the bread samples. Ndife *et al.* (2011) reported similar results (low carbohydrate and energy bread sample) which they also attributed to low-fat content of the composite bread. The energy contents of the bread samples under study (267.57 – 280.74Kcal/100g) were

conformed to the recommended minimum energy content of 1674KJ/100g by (FAO/WHO, 1994).

### **The Physical Parameters of Bread Samples**

Results of the physical parameters of bread samples containing different levels of dough improvers (EDC and CMC) as compared to the control sample showed that there were significant differences ( $p < 0.05$ ) among these bread samples and control sample (Table 4). The loaf volume of bread samples without EDC and CMC was 3761.60cm<sup>3</sup> (bread from higher gluten wheat flour) and 2,999.42cm<sup>3</sup> (bread from lower gluten wheat flour). The loaf volumes of the other six samples made with the inclusion of EDC and CMC were higher (3595.49 – 4709.38cm<sup>3</sup>) than their corresponding control sample. Their higher loaf volume could be attributable to the dough improvers (EDC / CMC) added which raises the dough thereby increasing the loaf volumes of the samples. Gomez *et al.* (2004) reported that EDC and CMC when used as ingredients in bread make the dough stronger with improved texture and volume.

### **Sensory Evaluation**

Results of the sensory evaluation of the bread samples containing different levels of bread improvers (EDC / CMC) compared to control samples (bread without EDC / CMC) are shown in (Table 5). Significant differences ( $p < 0.05$ ) were noticed among the bread samples in all sensory parameters evaluated. Bread samples baked with EDC / CMC were rated highest by the taste panelists; this was probably because EDC and CMC being an improver had contributed to the improvement of the desirable characteristics such as crust color, texture, mouthfeel and overall acceptability of the bread samples. The result of the bread crust color and crumb texture did not show a consistent pattern for all the bread samples, and there were significant differences ( $p < 0.05$ ) in the bread samples and the control sample. However, there were no significant differences ( $p > 0.05$ ) between the control sample, GPF (sample made from higher gluten flour) and others that were made from lower gluten wheat flour but with the inclusion of EDC / CMC in their crust colour. In contrast, the crust color of the bread sample made from lower gluten flour without the inclusion of EDC / CMC differed significantly ( $p < 0.05$ ) from the other three samples (GPCF2, GPCF3 and GPCF4) made from low gluten wheat flour but with inclusion of different levels of EDC / CMC. Sample GPCF2, bread made from lower gluten wheat flour with inclusion of 0.4% EDC and 1.0% CMC was rated highest (8.10±1.10) in appearance. Its

crust was observed to be golden brown in colour while the crumb (the inner part) was light brown in colour. This could be attributed to the bread improver (EDC/CMC) used which was combined to give the bread golden crust colour. The brownish colour of the bread usually occurs as a result of caramelization and Maillard reactions, that is, a reaction between the protein of flour and sugar during the baking process (Dhingra and Jood, 2001; Mohsen *et al.*, 2009). The darker color of the crumbs of the whole wheat breads has been reported (Akhtar *et al.*, 2008; Serrem *et al.*, 2011). The crumb texture of bread samples made with EDC/CMC were rated higher (7.43 -8.10) than the control sample (7.10). This showed that the crumb texture of the samples with EDC/CMC were better and preferred by almost all the taste panelists. The reason for this could be because dough raised enough because of the dough improver added and gave bread

samples a better texture and shape. Also, the baking conditions (temperature and time variables); state of the bread components such as fibre, starch, protein (gluten) and the amounts of absorbed water during dough mixing, all contributed to the final texture of the breads (Gomez *et al.*, 2008; Bakke and Vickers, 2007; Akhtar *et al.*, 2008; Serrem *et al.*, 2004).

Generally, the bread samples were all accepted by the taste Panelists but bread samples made from higher gluten wheat flour with 0.4% EDC / 1.0% CMC (GPF2) and sample GPF3 (with 1.0% EDC / 0.2% CMC) were most preferred with the mean scores of 7.90 and 7.63. There was no significant differences ( $p>0.05$ ) between these two samples (GPF2 and GPF3), but they differed significantly ( $p<0.05$ ) with the other samples.

Table 3. Proximate Composition of Bread Samples

Samples	Moisture (%)	Crude Protein (%)	Ash (%)	Crude Fibre (%)	Crude Fat (%)	Carbohydrate (%)	Energy (Kcal/100g)
GPF1	31.20±0.02 <sup>e</sup>	8.60±0.02 <sup>d</sup>	1.65±0.01 <sup>e</sup>	1.13±0.02 <sup>f</sup>	3.20±0.01 <sup>g</sup>	54.22±0.04 <sup>b</sup>	280.07±0.22 <sup>b</sup>
GPF2	34.49±0.01 <sup>a</sup>	8.85±0.00 <sup>a</sup>	1.87±0.00 <sup>a</sup>	1.38±0.01 <sup>a</sup>	3.46±0.00 <sup>d</sup>	49.94±0.02 <sup>g</sup>	266.31±0.06 <sup>h</sup>
GPF3	34.46±0.02 <sup>a</sup>	8.77±0.02 <sup>c</sup>	1.71±0.02 <sup>d</sup>	1.23±0.03 <sup>d</sup>	3.72±0.02 <sup>a</sup>	50.10±0.03 <sup>f</sup>	268.99±0.23 <sup>e</sup>
GPF4	34.47±0.03 <sup>a</sup>	8.81±0.10 <sup>b</sup>	1.80±0.00 <sup>b</sup>	1.31±0.01 <sup>b</sup>	3.57±0.01 <sup>b</sup>	50.04±0.01 <sup>f</sup>	267.57±0.15 <sup>g</sup>
GPCF1	31.11±0.04 <sup>f</sup>	8.60±0.01 <sup>d</sup>	1.56±0.02 <sup>f</sup>	1.10±0.02 <sup>g</sup>	3.19±0.01 <sup>g</sup>	54.40±0.08 <sup>a</sup>	280.74±0.34 <sup>a</sup>
GPCF2	34.10±0.00 <sup>b</sup>	8.86±0.01 <sup>a</sup>	1.75±0.03 <sup>c</sup>	1.28±0.02 <sup>c</sup>	3.29±0.01 <sup>f</sup>	50.73±0.04 <sup>e</sup>	267.93±0.14 <sup>f</sup>
GPCF3	33.12±0.01 <sup>d</sup>	8.77±0.02 <sup>c</sup>	1.62±0.02 <sup>e</sup>	1.13±0.02 <sup>f</sup>	3.50±0.02 <sup>c</sup>	51.87±0.03 <sup>c</sup>	274.00±0.06 <sup>c</sup>
GPCF4	33.80±0.02 <sup>c</sup>	8.81±0.01 <sup>b</sup>	1.68±0.03 <sup>de</sup>	1.19±0.01 <sup>e</sup>	3.32±0.01 <sup>e</sup>	51.20±0.00 <sup>d</sup>	269.90±0.06 <sup>d</sup>

Values are the mean of the samples ± Standard Deviation of the Triplicates. Values with different Superscript along the same column are significantly different (p<0.05).

GPF = Golden Penny Flour (High gluten wheat flour); GPCF = Golden Penny Confectionary Flour (Low gluten wheat flour); GPF1= Bread made from GPF without EDC and CMC; GPF2 = Bread made from GPF with EDC (0.4%) and CMC (1.0%); GPF3 = Bread made from GPF with EDC (1.0%) and CMC (0.2%); GPF4 = Bread made from GPF with EDC (0.8%) and CMC (0.8%); GPCF1 = Bread made from GPCF without EDC and CMC; GPCF2 = Bread made from GPCF with EDC (0.4%) and CMC (1.0%); GPCF3 = Bread made from GPCF with EDC (1.0%) and CMC (0.2%); GPCF4 = Bread made from GPCF with EDC (0.8%) and CMC (0.8%); EDC = Edlen Dough Conditioner ;CMC=Carboxymethylcellulose.

Table 4: The Physical Parameters of the Bread Samples

Bread Samples	SAMPLES	Loaf Volume (cm <sup>3</sup> )	Loaf Weight (g)	Specific (cm <sup>3</sup> /g)	Loaf Dough Yield (Number of Loaves)	Left over (g)
GPF1	GPF1	3761.60±7.18 <sup>f</sup>	805.19±3.92 <sup>b</sup>	4.67±0.02 <sup>e</sup>	9.00±0.58 <sup>c</sup>	500.12±0.13 <sup>b</sup>
GPF2	GPF2	4510.69±9.59 <sup>b</sup>	808.28±1.74 <sup>ab</sup>	5.58±0.01 <sup>b</sup>	12.00±0.00 <sup>a</sup>	40.28±0.22 <sup>g</sup>
GPF3	GPF3	4709.38±9.95 <sup>a</sup>	811.93±1.75 <sup>a</sup>	5.80±0.01 <sup>a</sup>	10.00±0.58 <sup>b</sup>	260.48±0.38 <sup>c</sup>
GPF4	GPF4	4386.08±4.61 <sup>d</sup>	808.17±2.13 <sup>ab</sup>	5.43±0.02 <sup>d</sup>	10.00±0.58 <sup>b</sup>	80.91±0.16 <sup>e</sup>
GPCF1	GPCF1	2999.42±12.2 <sup>h</sup>	790.58±0.42 <sup>d</sup>	3.80±0.02 <sup>g</sup>	7.00±0.58 <sup>d</sup>	750.08±0.00 <sup>a</sup>
GPCF2	GPCF2	4411.16±1.02 <sup>c</sup>	797.57±2.97 <sup>c</sup>	5.53±0.02 <sup>c</sup>	9.00±0.58 <sup>c</sup>	100.47±0.10 <sup>d</sup>
GPCF3	GPCF3	3695.49±5.49 <sup>g</sup>	796.27±3.07 <sup>c</sup>	4.64±0.01 <sup>f</sup>	9.00±0.00 <sup>c</sup>	80.29±0.35 <sup>e</sup>
GPCF4	GPCF4	4287.47±1.99 <sup>e</sup>	791.09±0.10 <sup>d</sup>	5.42±0.01 <sup>d</sup>	9.00±0.58 <sup>c</sup>	60.86±0.80 <sup>f</sup>

Values are the mean of the samples ± Standard Deviation of the Triplicates. Values with different Superscript along the same column are significantly different (p<0.05).

GPF = Golden Penny Flour (High gluten wheat flour); GPCF = Golden Penny Confectionary Flour (Low gluten wheat flour); GPF1= Bread made from GPF without EDC and CMC; GPF2 = Bread made from GPF with EDC (0.4%) and CMC (1.0%); GPF3 = Bread made from GPF with EDC (1.0%) and CMC (0.2%); GPF4 = Bread made from GPF with EDC (0.8%) and CMC (0.8%); GPCF1 = Bread made from GPCF without EDC and CMC; GPCF2 = Bread made from GPCF with EDC (0.4%) and CMC (1.0%); GPCF3 = Bread made from GPCF with EDC (1.0%) and CMC (0.2%); GPCF4 = Bread made from GPCF with EDC (0.8%) and CMC (0.8%); EDC = Edlen Dough Conditioner; CMC = Carboxymethylcellulose.

Table 5: The Sensory Evaluation of Bread Samples

Bread Samples	Crust Colour	Crumb Texture	Flavour/ Mouth Feel	Shape of the Loaf	Overall Acceptability
GPF1	7.00±1.01 <sup>b</sup>	7.10±0.98 <sup>d</sup>	7.18±0.96 <sup>c</sup>	7.30±0.99 <sup>c</sup>	6.30±1.71 <sup>c</sup>
GPF2	7.30±1.02 <sup>b</sup>	7.88±1.14 <sup>abc</sup>	8.18±1.08 <sup>ab</sup>	7.78±1.19 <sup>abc</sup>	7.90±1.30 <sup>a</sup>
GPF3	7.43±1.06 <sup>b</sup>	8.05±1.01 <sup>a</sup>	8.35±0.74 <sup>a</sup>	8.00±1.15 <sup>a</sup>	7.63±1.21 <sup>a</sup>
GPF4	7.28±1.22 <sup>b</sup>	7.43±1.11 <sup>cd</sup>	7.98±1.03 <sup>abc</sup>	8.05±1.06 <sup>a</sup>	6.25±1.37 <sup>c</sup>
GPCF1	7.08±1.02 <sup>b</sup>	7.35±1.25 <sup>cd</sup>	7.80±1.18 <sup>bcd</sup>	7.35±1.33 <sup>bc</sup>	6.33±1.27 <sup>c</sup>
GPCF2	8.10±1.10 <sup>a</sup>	8.10±1.19 <sup>a</sup>	7.80±1.20 <sup>bcd</sup>	7.78±1.21 <sup>abc</sup>	6.70±1.04 <sup>bc</sup>
GPCF3	7.95±0.96 <sup>a</sup>	7.48±1.32 <sup>bcd</sup>	7.58±1.11 <sup>cde</sup>	7.88±1.04 <sup>ab</sup>	6.98±1.19 <sup>b</sup>
GPCF4	7.93±1.12 <sup>a</sup>	8.00±1.30 <sup>ab</sup>	7.40±1.13 <sup>de</sup>	8.00±1.04 <sup>a</sup>	6.83±1.01 <sup>bc</sup>

Values are the mean of the samples ± Standard Deviation of the Triplicates. Values with different Superscript along the same column are significantly different (p<0.05).

GPF = Golden Penny Flour (High gluten wheat flour); GPCF = Golden Penny Confectionary Flour (Low gluten wheat flour); GPF1= Bread made from GPF without EDC and CMC; GPF2 = Bread made from GPF with EDC (0.4%) and CMC (1.0%); GPF3 = Bread made from GPF with EDC (1.0%) and CMC (0.2%); GPF4 = Bread made from GPF with EDC (0.8%) and CMC (0.8%); GPCF1 = Bread made from GPCF without EDC and CMC; GPCF2 = Bread made from GPCF with EDC (0.4%) and CMC (1.0%); GPCF3 = Bread made from GPCF with EDC (1.0%) and CMC (0.2%); GPCF4 = Bread made from GPCF with EDC (0.8%) and CMC (0.8%); EDC = Edlen Dough Conditioner; CMC = Carboxymethylcellulose.

## Conclusion

The results obtained in this research work have shown that good quality and acceptable bread could be produced by the inclusion of dough improvers, Edlen Dough Conditioner (EDC) and Carboxymethylcellulose (CMC) at up to 1.0% level with other bread recipes in bread production as this gave a good quality and improved loaves.

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