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Quality Evaluation of Maize and Black Bean Composite Flours

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ABSTRACT

The Glycemic Index (GI) is a metric used to assess a food's ability to elevate blood glucose levels after consumption. The fortified samples demonstrated a good effect on the reduction of blood glucose levels, replacing black bean with maize flour can be utilized to improve the nutritional content, blood glucose level for diabetes patients, and other quality attributes. The findings also demonstrated that maize and black bean flours will contribute to a decrease in the global prevalence of protein energy malnutrition, particularly in developing countries. By applying a cutoff value of larger than seventy (>70) to indicate high glycemic foods, 55-69 indicating medium glycemic foods, and (<55) and below showing low glycemic meals, the in vivo glycemic index employing maize and black bean composite flour was conducted. The ratios A= (100 maize flour served as control), B= (90 MF and 10% BBF), C= (85% MF and 15% BBF), D= (80% MF and 20% BBF), and E= (75% MF and 25% BBF) were used to obtain the flours made from maize and black bean. Albino rats were used to test products for the glycemic index. Full amino acid profiles and vitamin analyses were also carried out. With increasing levels of black bean flour substitution, the fortified samples' glycemic analysis revealed a decrease over time compared to the control. As the degree of substitution rose, the chemical analysis revealed an increase in each of their respective ratios. Findings addressed the issue of undernourishment in developing countries and offered a well-rounded/balanced meal.

Keyword: maize flour, black bean, invivo, amino acids, vitamins studies.

1. Introduction

Maize, is the most common food product consumed in the carbohydrate family after rice and wheat, it is low in essential amino acids like lysine, tryptophan, and threonine, with lysine being the most limiting amino acid (Ezeogu *et al.*, 2008). It can be boiled or roasted (Hugo, 2010., Olanipekun *et al.*, 2015 and Adeyeye *et al.,* 2017). In Nigeria, one of the culinary items made from maize is called maize *tuwo*. It is essentially a food gel or dumpling which is stiff, has a yield value and can be moulded into shapes (Muller, 1970). However, the utilization of *tuwo* and maize generally is limited by its extremely low protein content and so the consumption of its products has been implicated in malnutrition

Black bean (Phaseolus vulgaris L.) is a nutrient-dense food that contain fiber, proteins, minerals, and vitamins that are paramount to human health. According to Vermylen *et al.* (1991) and Kotou *et al*. (2018), black bean have a high protein quality and a wide variety of cultivars with high enough levels of essential and nonessential amino acids to meet daily nutritional requirements.

Starch is mostly composed of long chains of glucose called amylose and amylopectin, black beans have a higher proportion of amylose (30–40%) than most other dietary sources of starch. Because amylose is less digestible than amylopectin (Thomas *et al.,* 1993). Bean starch is a slow-release carbohydrate that takes longer to digest and raises blood sugar more gradually than other types of starch, making it especially beneficial for people with diabetes. Resistant starch is the portion of starch that does not get digested in the large intestine.

A fascinating new potential is presented by resistant starch (Thomas *et al*., 1993). Because of this, compared to other starches, black bean starch has a slower rate of release from the digestive system, takes longer to digest, and results in a more gradual and lower rise in blood sugar, making it especially advantageous for those suffering from a variety of illnesses. The portion of starch that does not undergo digestion in the large intestine is known as resistant starch (Englyst and Cummings, 1992). There is intriguing new possibility with resistant starch. The objective of this research was the evaluation of invivo, amino acids and vitamin studies of maize And black bean composite flours

2.0 Materials and Methods

Black bean and maize samples were collected randomly from the wurukum market, Makurdi, Benue State during the period under review and the flour were prepared for the various analyses. All the diiferent analyses were carried out at the Department of Food Science, Federal University of Agriculture, Makurdi, Nigeria.

2.1. Preparation of Maize and Black Bean Flours

Both flours were prepared according to Bolade *et al*. (2002)'s procedure. After removing some stones and debris, the flour was ground with a pestle and mortar until it was homogenized, and it was then sieved through a 250 mm sieve cloth to extract the flour. In the laboratory, flour samples were stored at 260°C in airtight plastic bottles for chemical analysis.

2.2. Preparation of Maize Flour

The flow chart for the preparation of maize flour is showed in figure 1.

Maize Grain

↓

Sorting

↓

Milling

↓

Sieving (8mm sieving clothe)

↓

Maize flour

Fig 1: Maize Production Flow Chart

Source: Bolade *et al.* (2002)

Maize flour and black bean flour

↓

Blending

↓

Boiling

↓

Addition of slurry

↓

Sieving (8mm sieving clothe)

↓

Allow to stay on fire for 7 minutes

↓

Tuwo

Fig 2: Production flow chart for composite flour.

Source: Bolade *et al.* (2002) with slight modification.

Table one (1): ***Blend Formulation for Maize and Black Bean Composite Flours***

Samples	Maize Flour(MF)	Black Bean Flour	Total
A	100	-	100
B	90	10	100
C	85	15	100
D	80	20	100
E	75	25	100

The procedure for the preparation of the composite flour is showed in figure 2.

2.3. Analyses

2.3.1. Effect of resistant starch on glycemic index/glucose of maize flour by rat bioassay

Six groups of five were created out of thirty (30) albino rats (Englyst and Cummings, 1992). For animal feeding trials, four distinct flour mixes as well as a control were made. The experimental rats were fed using a modified version of (Etuk *et al.,* 2010) and kept in wire cages at room temperature with sanitary conditions after a 12-hour fast the previous night. Every day, the rats' blood glucose levels were monitored. Blood was extracted from the tails of rats by immersing them in a 450°C water bath, cutting off approximately one millimeter of the tail, and using a drop of blood, an Acu Check Active Gluconometer (Roche Switzerland) was used to measure blood sugar levels.

-Group (1): Control negative; rats fed on maize flour only

-Group (2): Rats fed on diet containing (90% maize flour and 10% black bean flour)

-Group (3): Rats fed on diet containing (85% maize flour and 15% black bean flour)

-Group (4): Rats fed on diet containing (80 % maize flour and 20% black bean flour)

-Group (5): Rats fed on diet containing (75% maize flour and 25% black bean flour)

2.3.2. Amino Acid Determination

The Rosen (1957) approach was used to qualitatively evaluate the amino acid (profile) content of the food compositions. The produced thin-layer chromatography plates were utilized to locate the locations of amino acids on unsprayed plates in order to estimate the amino acids using the guide strip technique. The cellulose powder was extracted by centrifugation at 5,000 rpm for five minutes after the squares containing amino acids were cut out and eluted with 5 ml of distilled water at 70°C for two hours. The supernatant was separated and preserved for the colorimetric evaluation of amino acid profiles in comparison to the reference values of each amino acid provided by the Food and Agricultural Organization (FAO).

2.3.4. Vitamin Contents of the Composite Flours

The AOAC (2012) methodologies were used to evaluate thiamine, riboflavin, niacin, and ascorbic acid (Vitamin C) of the composites

2.4. Statistical Analysis

To compare treatment means, the collected data were subjected to Analysis of Variance (ANOVA) and Tukey's Least Significant Difference (LSD) test; differences were deemed significant at the 95% level ($P \leq 0.05$) (using SPSS V21 software).

3.0 Results and Discussion

3.1. Glycemic analysis

Table two (2) displays the results of the glycemic analysis. The reference food's glycemic index rose, whereas the fortified samples further down the column showed the opposite trend. Across all samples, there was a significant ($p<0.05$) rise. The glucose content finding is consistent with the research (Dooshima *et al*., 2015).Also, Akanbi and Ikujenlola (2016) who worked on the physicochemical composition and glycemic index of whole grain bread produced from composite flours of quality protein maize and wheat reported that increasing inclusion of quality protein maize resulted in decline in the blood glucose content (glycemic index) of the fortified products against the reference food. Also, Akanbi and Ikujenlola (2016) conducted research on the physicochemical composition and glycemic index of whole grain bread made from composite flours of wheat and quality protein maize. They found that when quality protein maize was added in greater amounts, the fortified products' blood glucose content (glycemic index) decreased in comparison to the reference food.

According to this study, adding more black bean flour to the fortified samples caused the glycemic index to drop. This is because, in comparison to most other dietary sources of starch, beans have a comparatively high concentration of amylose. Consuming low-glycemic foods, such as beans, may reduce the chance of developing diabetes (Jenkins *et al*., 2002).

Low GI foods have been reported to have some physiological and metabolic advantages (Pasupuleti and Anderson, 2008) includes reduced rate of carbohydrate absorption in the small intestine, lower postprandial glucose rise; reduced daily insulin levels, fatter gastric inhibitory polypeptide response; decreased 24 hour urinary c-peptide output; prolong suppression of plasma free fatty acids among others. A person is regarded as diabetic if FBS > 7 mmol/l, 126 mg/dl or RBS >11mmol/200 mg/dl). If FBS > 7 mmol/l, 126 mg/dl, or RBS > 11 mmol/200 mg/dl, a person is considered diabetic. Using the threshold value of more than seventy (>70) to identify high GI foods (Brand-Miller *et al*., 2003), it is possible to identify the control sample (100 percent maize flour) as high GI food. Glycemic index values of 92.30 and 86.80 for agidi and tuwo masara, two porridges made from refined maize, are comparable to those of processed maize flour with a high GI value.

Although studies have shown that the glycemic indices of the various foods consumed within a meal can predict the glycemic index of the meal (Brouns et al., 2005), the data generated in this study can be useful in predicting the glycemic indices of mixed meals. Generally speaking, these foods should not be eaten alone; instead, they should be consumed in conjunction with legumes, vegetables, or meat in a meal.

Table 2: Glycemic analysis using albino rats by comparing the average blood glucose responses to glucose made from maize and black bean composites.

Times(mins)	**15**	**30**	**45**	**60**	**75**	**90**
Samples						
A	$70.89^{e}\pm 0.27$	$74.19^{e}\pm 0.09$	$76.31^{e}\pm 0.20$	$77.17^{e}\pm 0.60$	$80.14^{e}\pm 0.04$	$81.11^{e}\pm 0.05$
B	$64.06^{d}\pm0.09$	$63.05^{d}\pm0.08$	$59.02^{d}\pm0.07$	$58.19^{d}\pm0.05$	$56.02^{d}\pm0.06$	$51.78^{d}\pm0.19$
C	$63.02^{c}\pm0.09$	$59.03^{c}\pm0.40$	$58.85^{c}\pm0.09$	$55.03^{c}\pm0.07$	$54.07^{c}\pm0.05$	$51.04^{c}\pm0.08$
D	$60.68^{b}\pm0.92$	$56.18^{b}\pm0.93$	$55.19^{b}\pm0.91$	$54.17^{b}\pm0.89$	$53.14^{b}\pm0.86$	$50.19^{b}\pm0.44$
E	$50.19^{a}\pm0.56$	$49.19^{a}\pm0.24$	$48.15^{d}\pm1.08$	$43.13^{a}\pm0.26$	$39.69^{a}\pm0.89$	$35.19^{a}\pm0.88$
LSD	0.97	1.02	0.09	1.19	1.48	1.90

3.2. Amino Acid Analyses of Aaize and Black Bean Composite Flours

Table 3 displays the outcome of the black bean and maize flours (3). The chemical building blocks of proteins are called amino acids. Because proteins take part in the essential chemical reactions that keep life alive, they provide all living things their structural integrity. Table 3 illustrates how adding black bean flour to maize flour enhances the composite flours' amino acid profiles (3). In comparison to the FAO reference of 5.50 g/100 g, lysine and tryptophan increased significantly from 2.04 g/100 g to 4.21 g/100 g based on the essential amino acid composition and scores of the blend formulations assessed. In comparison to the FAO reference of 1.00 g/100 g, tryptophan values in the composite flours increased from 1.00 g/100 g to 1.33 g/100 g. The work of Gernah *et al.* (2012), who examined the nutritional and sensory aspects of food formulations made from malted maize enhanced with defatted sesame flour, is consistent with this tendency. Because proteins take part in the essential chemical reactions that keep life alive, they provide all living things their structural integrity. Table 3 illustrates how adding black bean flour to maize flour enhances the composite flours' amino acid profiles (3).

Table 3: Amino Acid analyses of maize and black bean composite flour

Samples/Parameters	A	B	C	D	E	LSD	FOA Reference
Alanine	1.84^{a}±0.02	1.88b±0.02	1.94c±0.020.02	2.00d±0.02	2.01^{a}±0.03	0.02	-
Aspartic acid	4.35^{a}±0.02	4.98^{b}±0.03	6.00^{e}±0.02	5.64^{c}±0.02	6.01^{d}±0.02	0.07	-
Arginine	4.29^{a}±0.02	4.97b±0.03	6.13^{e}±0.01	5.66^{c}±0.05	6.02^{d}±0.02	0.07	-
Glycine	1.42a±0.02	1.71b±0.02	1.75b±0.02	1.81^{c}±0.01	1.89^{d}±0.02	0.05	-
Glutamic acid	1.71±0.04	2.69b±0.02	3.97c±0.05	4.91cd±0.03	5.67±0.02	0.09	-
Serine	2.16a±0.03	2.20a±0.02	3.84^{c}±0.010.03	2.96^{b}±0.01	3.04c	0.06	-
Proline	0.64^{a}±0.03	2.01^{b}±0.02	2.45^{c}±0.04	2.51^{d}±0.02	2.59^{e}±0.040	0.05	-
Threoline	1.75a±0.11	2.84c±0.04	2.75b±0.06	2.79b±0.03	3.91d±0.02	0.04	4.00
Tryptophan	1.00^{a}±0.01	1.10^{b}±0.02	1.26^{c}±0.08	1.36^{cd}±0.02	1.40^{d}±0.08	0.06	1.00
Isoleucine	1.04^{a}±0.03	2.04^{b}±0.04	3.03^{c}±0.02	3.20^{d}±0.02	4.50^{e}±0.09	0.08	4.70
Leucine	3.25^{a}±0.05	3.25^{a}±0.05	4.40^{b}±0.01	5.5^{1}c±0.08	6.09^{d}±0.03	0.01	7.00
Lysine	2.05^{a}±0.07	2.23^{b}±0.04	3.11^{c}±0.02	3.84^{d}±0.02	4.44^{e}±0.06	0.08	5.50
Methionine	0.97^{a}±0.06	1.51^{b}±0.02	1.88^{c}±0.01	2.03^{d}±0.02	3.06^{e}±0.03	0.09	3.50
Phenylalanine	2.10^{a}±0.01	2.12^{a}±0.01	3.43^{b}±0.01	4.82^{c}±0.19	3.39^{b}±0.03	0.04	6.00
Tyrosine	1.77^{a}±0.01	2.09^{b}±0.01	2.10^{b}±0.01	2.26^{c}±0.02	2.47^{d}±0.11	0.01	-
Valine	2.59^{a}±0.02	3.07^{b}±0.02	3.04^{b}±0.01	3.52^{c}±0.02	4.59^{d}±0.01	0.03	5.00
Histidine	0.88^{b}± 0.06	0.92^{a}±0.01	0.99^{b}±0.00	1.02^{b}±0.01	1.14^{c}±0.02	0.08	-

Values are means standard of duplicate determinations

Means with same superscript in the same column are not significantly (P>0.05) different LSD: Least Significant Difference

Keys: A = (100 % Maize flour control) B = (90 % Maize and 10% black bean flour) C = (85% Maize and 15% black bean flours) D (80% Maize and 20% black bean flours), E (75% Maize and 25% black bean flours).

3.4. Vitamin Content of maize and black bean flours

The composite tuwo's vitamin analysis is displayed in Table four (4), where the vitamin contents considerably (($p<0.05$) rose down the column. Additionally, the coenzyme is involved in cell development, DNA repair, and replication. Pelagra is caused by a deficiency in certain vital vitamins. The growth and upkeep of teeth, gums, cartilage, and bones all depend on vitamin C (FOA/WHO/UNU, 1994). The composite flour's riboflavin (B2) level lends credence to the assertion made by Uchechukwu *et al.* (2017) that cofermented maize ogi with pigeon pea increased its vitamin B2 characteristics. According to UICEC/WHO (2005), riboflavin plays a role in both tissue development and energy metabolism. Riboflavin is a factor in energy metabolism and tissue formation (UICEC/WHO, 2005).

Table 4: Vitamin contents (mg/100 g) of maize and black bean composite flours

Samples	Thia**mine**	**Riboflavin**	**Niacin**	**Vitamin C**
A	0.86^{a}± 0.02	0.05^{a}± 0.03	0.44^{a}± 0.07	1.34^{a}± 0.09
B	0.88^{a}± 0.04	0.06^{a}± 0.01	0.52^{b}± 0.07	2.66^{b}± 0.29
C	0.89^{ab}± 0.01	0.07^{a}± 0.01	0.54b± 0.07	2.99^{c}± 0.03
D	0.92^{b}± 0.01	0.08^{a}± 0.01	0.60c± 0.07	3.14^{d}± 0.05
E	0.95^{b}± 0.01	0.09^{a}± 0.01	0.68b± 0.07	3.18^{d}± 0.29
LSD	0.15	0.13	0.10	0.08

Values are means standard of duplicate determinations

Means with same superscript in the same column are not significantly (P>0.05) different LSD: Least Significant Difference

Keys: A = (100 % Maize flour control) B = (90 % Maize and 10% black bean flour) C = (85% Maize and 15% black bean flours) D (80% Maize and 20% black bean flours), E (75% Maize and 25% black bean flours).

4. Conclusion and Recommendation

The fortified samples when compared to the control, in this investigation had a lower invivo glycemic index, suggesting that they would be a viable option for weight- and glycemic-management diets that aim for a later release of glucose. The results of the invivo glycemic index, amino acid profile, and vitamin analysis showed that blends of maize and black flour will play a major role in mitigating the issue of undernutrition in developing nations.

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