Original Research Article

EFFECTS OF FERMENTATION ON THE NUTRITIONAL COMPOSITION OF BANANA AND GROUNDNUT FLOUR BLENDS

ABSTRACT

The study was carried out to determine the effect of fermentation on the nutritional composition of banana and groundnut flour blends. Four blends of banana and groundnut flour was composed (50:50, 60:40, 100:0 and 0:100(banana:groundnut)). Each blend was fermented naturally at room temperature for 72 hours. The pH and total titratable acidity (TTA) were monitored at 24hour interval during fermentation. Mineral and antinutrient composition were also assessed using standard techniques. The pH of the fermenting samples decreased as fermentation progressed while total titratable acidity increased. Total microbial load of the samples decreased during fermentation. Antinutrients decreased while minerals increased after fermentation. From the research, it was observed that fermentation reduced the antinutrient contents of the samples while the minerals were enhanced, therefore food products from legume and carbohydrate blends should be fermented in order to increase the nutritional composition.

INTRODUCTION

Banana is a seed plant that produces edible fruits, usually seedless which belong to the specie*Musaacuminata*or are hybrids of*Musa acuminata* and*Musa balbisiana*. It is an edible fruit produced by several kinds of large herbaceous flowering plants in the genus of *Musa.* It is highly nutritive and very delicious.It contains about 74% water, 23% carbohydrate and 1% protein.Bananas are a valuable source of vitamin B_6, vitamin C, potassiumand fibre (USDAARS, 2018).Banana is monocarpic, flowering and setting fruit once before it dies.A healthy banana plant will have 8-12 leaves, fruits mature in 60-100 days after flowers first appears depending on the season and cultivar. New banana plants arise as suckers from an underground rhizome. As old plants die and new suckers are formed the rhizome expands and is called a mat. Bananas are propagated by suckers, pieces of the rhizome and by tissue culture (Ploetz, 2004).

Groundnut(*Arachishypogaea*)is an herbaceous annual plant in the family Fabaceae grown for its oil and edible nuts. Peanut plants are small, usually erect, thin stemmed plants with feather-like leaves.The groundnut pods can reach up to 10 cm in length and can contain between 1 and 5 seeds. The peanut plant can reach 0.6 m in height depending on the variety and as an annual plant.It is a rich source of protein, niacin, and vitamins E, vitamin B1, copper, zinc, vitamin B6, foliate, iron and has a high lysine content which makes it a good complement for cereal protein which is low in lysine (Okaka, 2005).

Fermentation has been known as one of the oldest food processing techniques. Fermentation has been known to improve food quality through biosynthesis and bioavailability of vitamins (Ojokoh and Fagbemi, 2016; Ijarotimi, 2012). This research is therefore focused on the effects of fermentation on the nutritional composition of banana and groundnut.

METHODOLOGY

COLLECTION OF SAMPLES

Fresh groundnut (*Arachishypogaea)* and fresh ripe banana (*Musaacuminata*) were locally obtained in Arena market, Oshodi, Lagos State, Nigeria. They were all transported to the laboratory in clean polyethylene bags.

PREPARATION OF THE SAMPLES

The groundnut was thoroughly cleaned by picking all the dirt present in them. It was dried, peeled and milled into flour.The groundnut flour was defatted by using a soxhlet extractor. The ripe bananawas cleaned with water to remove the sand particles present on the peel after which it was peeled. The banana pulp was cut into small slicesand oven dried. It was then milled into flour. The flour was sieved and stored in an air tight container.

PREPARATION OF COMPOSITE FLOUR

The banana (B) and groundnut (G) were formulated in ratio 50:50, 60:40, 100:0, 0:100 (banana: groundnut)

FERMENTATION OF SAMPLES

Sterile water was added to the flour blends in covered containers. The samples were allowed to ferment naturally at room temperature for 72 hours.

MICROBIOLOGICAL ANALYSIS

Microorganisms were isolated at 24hr interval during fermentation. The samples were subjected to microbiological analysis to monitor the growth and the changes in the population of microorganisms responsible for the fermentation of the samples.The organisms were characterized based on biochemical and morphological observations according to the methods ofCheesebrough (2006).

pHDetermination

The pH of the samples was determined according to the method of A.O.A.C (2012). Twograms of sample was mixed in 20ml distilled water. The mixture was allowed to stand for 15 minutes, shaken at 5 min interval and filtered with Whatman No. 1 filter paper. The pH of the filtrate was measured using a pH meter (Model HM-305, Tokyo, Japan).The pH meter was standardized using standard buffer of pH 4.0 and 7.0.

Total Titratable Acidity

A 10 ml of the filtrate was measured into a beaker and 2 drops of phenolphthalein was added into it. This was titrated with 0.1 M sodium hydroxide (NaOH) solution and the titre value was read. Total titratable acidity was expressed as percent (%) lactic acid.

Mineral Analysis

The mineral analysis was determined by the method described by AOAC (2012). The samples were ashed at 550°C.Sodium (Na) and potassium (K) were determined using the standard flame emission photometer. Phosphorus was determined calorimetricallywhile calcium (Ca), magnesium (Mg), and iron (Fe) were determined using an atomic absorption spectrophotometer; all values were expressed in mg/100 g.

Determination of Anti-nutritional Factors

The anti-nutrients saponin, calcium oxalate, trypsin inhibitors, tannins, and phytate levels in the fermented and unfermented samples were determined using the method of A.O.A.C (2012).

RESULTS

The changes in pH of each sample during fermentation decreased with the days of fermentation. 100% banana flour had the highest pH value of 6.66 at 0hour while 50% banana: 50%groundnut flour formulation had the lowest pH value of 4.08 at 72 hours. This is illustrated in table 1.

Table 2 shows the change in temperature of each sample during fermentation which decreased with the days of fermentation. 60% banana: 40%groundnut flour formulation had the highest temperature value of 31.2^{0}C at 0hour while 100%groundnut flour formulation had the lowest temperature value of 22.4^{0}C at 72hours.

Table 3 shows the result of total titrable acidity during fermentation which values increases as the pH decreases. 100% banana flour formulation had the highest titrable value of 6.53 at 72hours while 100% groundnut flour formulation had the lowest titrable value of 4.13 at 0hour.

Table 1: Changes in pH During Fermentation of Banana-Groundnut Blends

	Fermentation Period			
SAMPLE	**0 HOUR**	**24 HOURS**	**48 HOURS**	**72 HOURS**
A	4.57±0.02	4.44±0.05	4.21±0.10	4.08±0.01
B	6.01±0.05	5.91±0.02	5.64± 0.11	5.43±0.01
C	5.78±0.01	5.42±0.01	5.21±0.02	5.02±0.06
D	6.66±0.00	6.15±0.00	5.51±0.05	5.28±0.00

A = Banana flour (50g) + Groundnut flour (50g) **B** = Banana flour (60g) + Groundnut flour (40g)
C = Banana flour (0g) + Groundnut flour (100g) **D** = Banana flour (100g) + Groundnut flour (0g)

Table2: Changes in Temperature During Fermentation of Banana-Groundnut Blends

	Fermentation Period			
SAMPLE	**0 HOUR (^{0}C)**	**24 HOURS (^{0}C)**	**48 HOURS (^{0}C)**	**72 HOURS (^{0}C)**
A	30.3±0.00	27.1±0.01	26.4±0.00	25.2±0.01
B	31.2±0.01	25.3±0.00	24.9±0.01	22.8±0.00
C	27.4±0.00	24.4±0.02	23.0±0.10	22.4±0.00
D	30.8±0.00	29.6±0.02	28.3±0.15	27.6±0.00

A = Banana flour (50g) + Groundnut flour (50g) **B** = Banana flour (60g) + Groundnut flour (40g)
C = Banana flour (0g) + Groundnut flour (100g) **D** = Banana flour (100g) + Groundnut flour (0g)

Table 3:Changes in Titrable AcidityDuring Fermentation of Banana-Groundnut Blends

	FERMENTATION PERIOD			
SAMPLE	**0HOURS**	**24HOURS**	**48HOURS**	**72HOURS**
A	5.20±0.05	5.22±0.01	5.31±0.00	5.46±0.10
B	5.72±0.01	5.78±0.05	6.01±0.02	6.27±0.05
C	4.13±0.03	5.80±0.02	5.91±0.01	6.43±0.03
D	5.83±0.03	6.20±0.02	6.31±0.00	6.53±0.05

Keys:

A = Banana flour (50g) + Groundnut flour (50g)**B** = Banana flour (60g) + Groundnut flour (40g)
C = Banana flour (0g) + Groundnut flour (100g)**D** = Banana flour (100g) + Groundnut flour (0g)

TABLE 4: Microbial Count During Fermentation of Ripe Banana-Groundnut Blend

	Bacteria (cfu/ml) ($x10^4$)				Lactic Acid Bacteria (cfu/ml) ($x10^4$)				Fungi (sfu/ml) ($x10^4$)			
Sample	0hr	24hr	48hr	72hr	0hr	24hr	48hr	72hr	0hr	24hr	48hr	72hr
A	8.0	1.0	6.0	2.4	4.0	0.4	4.0	1.6	8.0	1.0	0.9	1.2
B	5.0	1.7	1.3	1.9	6.0	0.6	4.0	0.5	9.0	4.0	1.0	0.6
C	7.0	1.0	1.2	2.2	4.0	0.7	1.0	1.8	9.0	4.0	1.0	0.3
D	9.0	1.0	0.8	2.2	8.0	0.5	0.9	0.8	10.0	3.0	1.2	1.0

Keys:
A = Banana flour (50g) + Groundnut flour (50g) **B** = Banana flour (60g) + Groundnut flour (40g)
C = Banana flour (0g) + Groundnut flour (100g) **D** = Banana flour (100g) + Groundnut flour (0g)

Figure 1-5 shows the antinutrient composition of raw and fermented ripe Banana-Groundnut blend. Glycosides, Flavonoid and Tannin values decreased after fermentation while Phytic acid and Alkaloid increased after fermentation.

Glycosides recorded the highest value in 100% formulation of unfermented groundnut (C) (24.09±0.03)and the lowest in fermented 50%Banana: 50% Groundnut (A) formulation (9.28±0.01). Phytic acid recorded highest value in fermented 60% Banana: 40% Groundnut (B) formulation (27.93±0.01) and the lowest in unfermented 60% Banana: 40% Groundnut formulation (12.54±0.01).

Flavonoid recorded the highest value in 100% formulation of unfermented groundnut (21.29±0.01) and the lowest value in fermented 50% Banana: 50% Groundnut formulation (4.23±0.01). Tannin recorded the highest value in unfermented 100% Groundnut formulation (4.68±0.01) and the lowest value in fermented 60%Banana: 40% groundnut formulation (0.05±0.00) while Alkaloid recorded the highest value in unfermented 60% Banana: 40% Groundnut formulation (34.18±0.01) and the lowest value in unfermented 100% formulated Groundnut concentration (3.19±0.01).

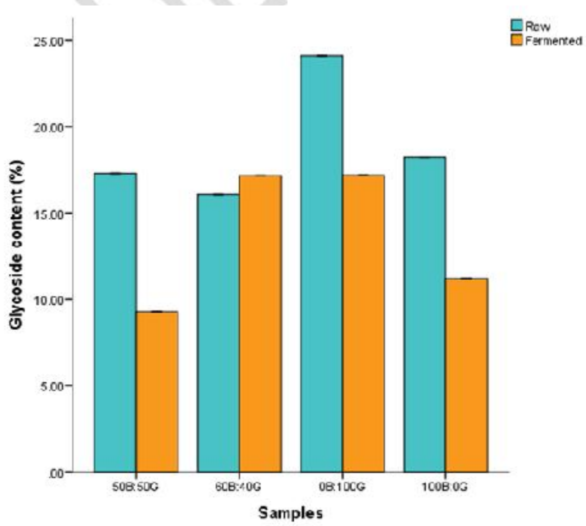

Figure 1: Percentage Glycoside Content of Fermented and Unfermented Ripe Banana-Groundnut blend

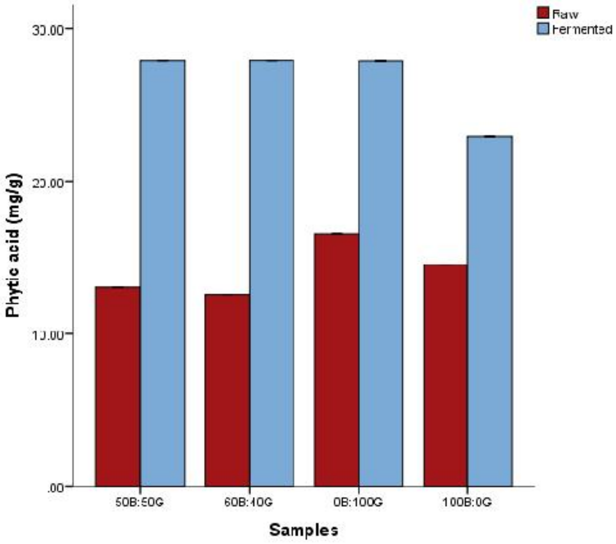

Figure 2: Phytic acid (mg/g) Content of Fermented and Unfermented Ripe Banana-Groundnut blend

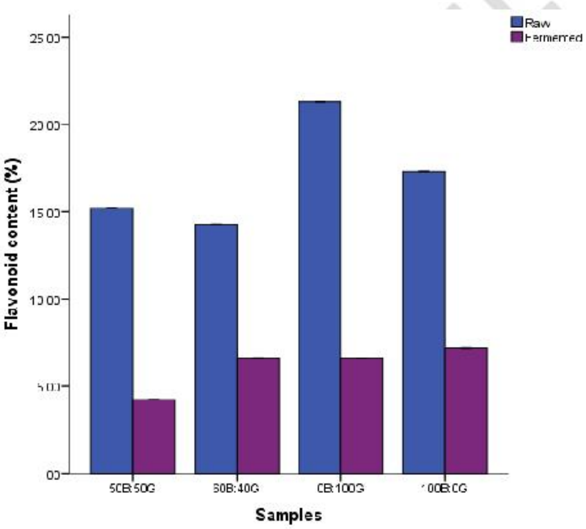

Figure 3: Percentage Flavonoid Content of Fermented and Unfermented Ripe Banana-Groundnut blend

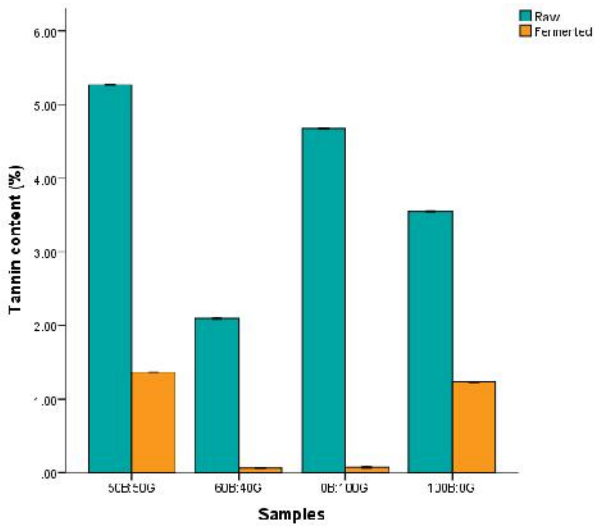

Figure 4: Percentage Tannin Content of Fermented and Unfermented Ripe Banana-Groundnut blend

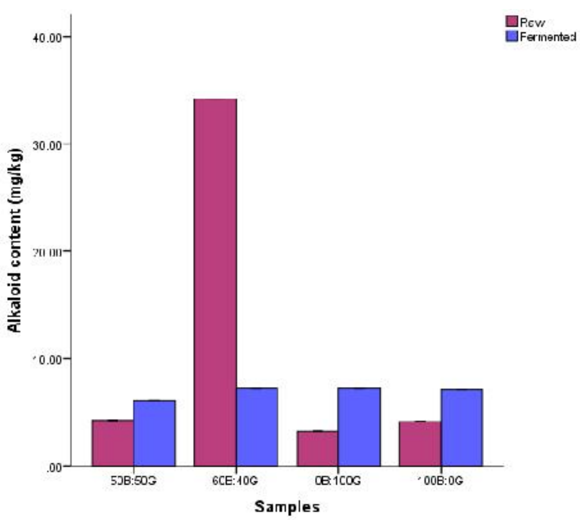

Figure 5: Alkaloid (mg/g) Content of Fermented and Unfermented Ripe Banana-Groundnut blend

The mineral composition of ripe Banana-Groundnut blends increased after fermentation process. Sodium recorded the highest value of 31.03±0.01in fermented 50%Banana: 50% Groundnut formulation and the lowest value of 8.06±0.02 in unfermented 100% groundnut formulation while Potassium recorded the highest value of 22.64±0.01 in fermented 50% Banana: 50% Groundnut formulation.Calcium recorded the highest value of 31.08±0.01 in unfermented 100% banana formulation and the lowest value of 7.31±0.02 in unfermented 60% Banana: 40% Groundnut formulation while Magnesium recorded the highest value of 43.22±0.01 in fermented 50% Banana: 50% Groundnut formulation and the lowest value of

19.69±0.02 in unfermented 50% Banana : 50% Groundnut formulation.Iron recorded the highest value of 45.05±0.01 in fermented 50% banana; 50% Groundnut formulation and the lowest value of 21.14±0.02 in unfermented 50% Banana: 50% Groundnut formulation.

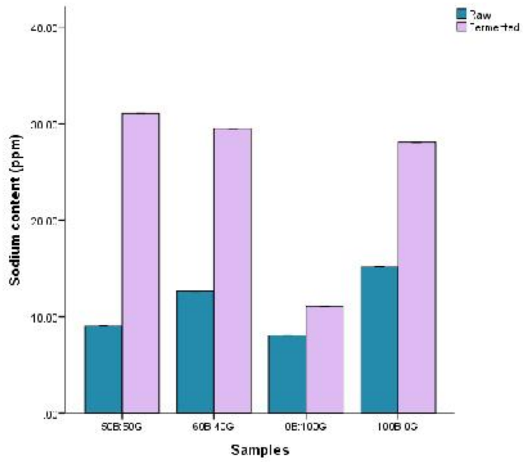

Figure 6: Sodium (ppm) Content of Raw and Fermented Ripe Banana-Groundnut blend

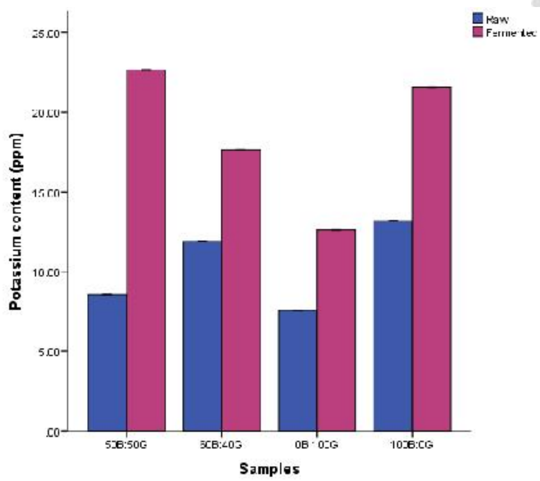

Figure 7: Potassium (ppm) Content of Raw and Fermented Ripe Banana-Groundnut blend

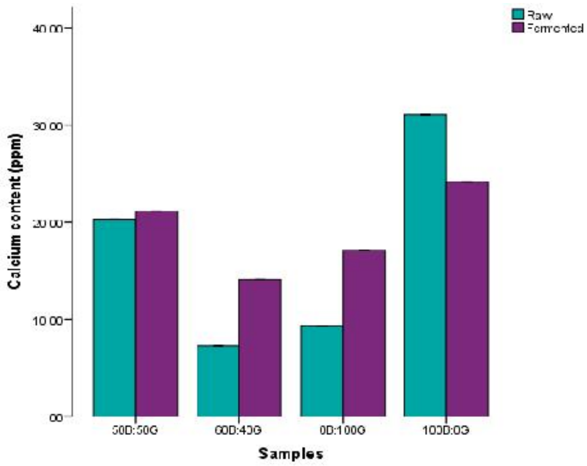

Figure 8: Calcium (ppm) Content of Fermented and Unfermented Ripe Banana-Groundnut blend

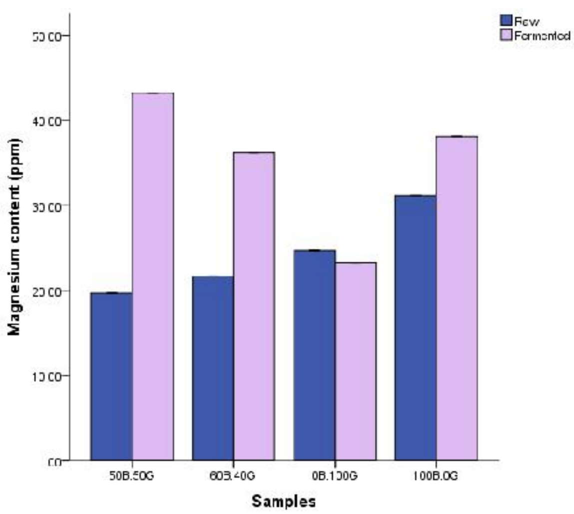

Figure 9: Magnesium (ppm) Content of Fermented and Unfermented Ripe Banana-Groundnut blend

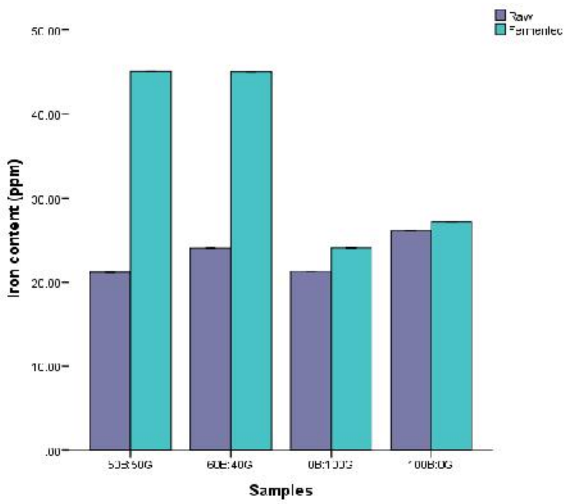

Figure 10: Iron (ppm) Content of Fermented and Unfermented Ripe Banana-Groundnut blend

Key:

50B:50G = 50%Banana flour: 50% Groundnut flour
60B:40G = 60%Banana flour: 40% Groundnut flour
0B:100G = 0%Banana flour: 100% Groundnut flour
100B:0G = 100%Banana flour: 0% Groundnut flour

DISCUSSION

Decrease in pH and increase in total titratableacdity (TTA) as fermentation progressed is in agreement with the findings of Mbate*et al.,* (2007) and Ojokoh and Fagbemi (2016). Increase in titratable acidity could be due to the presence of lactic acid bacteria in the environment which degrade carbohydrates resulting in acidification (Nout*et al*., 1989).The fermenting samples had high initial microbial load which later decreased as fermentation progressed. This is contrary to the report of various researcher who reported initial increase of microbial load followed by a decrease in the microbial load.

There was reduction in the antinutrient composition of the samples after fermentation. Glycoside content of sample A decreased significantly after fermentation. Sample B showed no significant difference after fermentation. It was observed that unfermented sample C had the highest glycoside content which was greatly reduced after fermentation. There was also significant decrease in sample D after fermentation. From the results, it was observed that fermentation had no positive impact on the phytic acid content of the blends. The flavonoid content of all the samples was greatly decreased after fermentation. There was significant decrease in the tannin content of the fermented blends when compared with the unfermented blends. However, samples B and C recorded the least tannin content after fermentation. Alkaloid only decreased significantly in sample B after fermentation, other samples recorded no significant difference after fermentation. Decrease in the antinutrient contents of the samples may be due to the ability of the fermenting organisms to break down these antinutrients. Fetuga (2013) reported that different processing methods such as cooking, autoclaving and soaking have an influence in reducing the antinutritional factors of foods.

The sodium and potassium contents of all the samples increased significantly after fermentation. There was increase in the calcium content of samples A, B, and C after fermentation. However, sample D recorded a lower calcium content. Magnesium content increased after the fermentation of samples A, B and D, while there was no significant difference in sample C. there was significant increase in the iron content of samples A and B after fermentation, while slight increase was recorded for samples C and D. Increase in the mineral composition of the samples may be due to the reduction in the antinutrients. It has been reported that antinutrients tie up minerals in food thereby making them unavailable in the food. Hence, the reduction of these antinutrients could be responsible for increase in the mineral composition. Potassium was the most abundant mineral present in the sample formulation. This result was consistent with the findings of Lewu*et al*., (2010); Osagie (1998) and Onyeka (2008).

CONCLUSION

Considering the mineral and antinutrient properties of the food blends (raw blends and fermented blends), fermentation had considerable impact on the nutritional composition of the banana and groundnut flour blends. Furthermore, fermentation could be explored more by food processing industries to improve the overall acceptability of food blends.

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