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BAOBAB FLOUR TECHNOLOGY

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ABSTRACT

One of the Big 4 agenda of the government of Kenya is Food security. Achieving food and nutritional security is a pre-requisite to eradicating poverty, child malnutrition and material mortality. It is the foundation of National economic growth and supports the social pillar of Kenya vision 2030. Food insecurity and malnutrition remains two major problems in Kenya that cause under –nutrition and nutrient deficiencies. In a bid to combat the problem, the government has targeted increased production of the micronutrient (minerals and vitamins) fortified maize flour and cooking oil. But mostly based on chemical fortificants. Nutritionists have come up with food to food fortification methods that are organic and cheaper, for example the use of Amaranth and pumpkin seeds in fortifying grain flour. However children taking the porridge have sometimes not gladly welcomed it because of the mixed taste it produces. Hence there is need to fortify the grain flour using a different alternative that will motivate children to drink the porridge. The objective of this study was to fortify grain flour using baobab fruit pulp powder to improve the nutritional content of the flour. The specific objectives of the project were to improve the nutritional content of grain flour; to increase the shelf life of grain flour and to provide a cheaper method of fortifying grain flour. The parameters analyzed were the proximate analysis of some nutrients, monitoring shelf life and cost of fortifying baobab enriched grain flour. These parameters formed the basis of data collection. From the data, it was concluded that baobab improves the nutritional content of the flour. Baobab adds fiber value, although in minimal amounts. It was also established that there is an increasing trend of protein added to the flour as the quantity increases. As the amount of baobab pulp increases, the carbohydrate content also increases. Baobab also adds more vitamin C to the flour. Baobab is a preservative as there is a significant decrease in the number of E-Coli as the quantity of baobab pulp powder increases which proves that it increases the shelf life of the flour. It was also noted it is relatively cheaper to fortify baobab flour compared to other methods of fortification. The study recommends further analysis and tests on the fortified flour to prove if other nutrients which are not tested in this report are present. The study recommends investigation on the influence of temperature, time and PH on the final fortified flour.

Index Terms – Fortification, Shelf-life and Nutritional content.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Vitamins, minerals and carbohydrates are essential micronutrients for human growth and wellbeing in Kenya (Adolphe, Dahl, Whiting & Tyler, 2006). Young children are highly vulnerable because of their rapid growth, inadequate dietary practices and behavior of choosing what to take and what not to take (Akner & Floistrup, 2003). Alleviation of these nutritional concerns can be achieved efficiently through food fortification, one of the most cost effective strategies to deliver micronutrients to large populations (Basu, 2006). Food fortification has the advantages of enabling nutrients delivery to large segments of the population without requiring radical changes in food consumption patterns (FAO, 2006).

In response, the government has introduced compulsory fortification on flour and cooking oil product in Kenya (Chapman, 2006). However, the use of fortification formula from chemical ingredients is difficult and poorly sustainable. Therefore, a food to food fortification could be an advantage (FAO, 2006). Many entrepreneurs have already come up with different ways of fortifying grain flour with different food to food ingredients which include Amaranth (mchicha), pumpkin seeds, and Moringa seeds among others. Children aged four to six years tend to have negative attitude towards porridge because of the fortification with many ingredients which produce a taste that children do not like (WHO, 2012).

The baobab (*Adansonia digitata*) belongs to the Bombacaceae family (Gibson, 2005). It produces large green or brownish fruits which are capsules and characteristically indehiscent. The capsule contain a soft whitish powdery pulp, kidney shaped seeds (Keller, 2004). 100g of baobab fruit pulp dry weight contains an average 1.1-10.4 mg of Iron, 390-700.9 mg of calcium, and up to 1.7 mg of Zinc (Miller, 2006). Baobab fruit pulp contains all the essential amino acids (WHO, 2012). This ingredient can be important in fortifying porridge due to its acceptability among the children. The Baobab fruit pulp is commonly known as “Mabuyu” (Utiger, 1998). The baobab fruit has a very resistant capsule named epicarp and an internal portion, the fruit pulp, named endocarp (Miller, 2006). The ripe fruit pulp appears as naturally dehydrated powdery, whitish colored and with a slightly acidulous taste. It is split in small floury agglomerates that enclose multiple seeds. It contains filaments that subdivide the fruit in segments and its separation only needs a single mechanical process without any extraction, concentration or chemical treatment (WHO, 2012)..

According to FAO (2006), the quantity of baobab per 100g of pulp is:

- 75.6 percent of total carbohydrates
- 32.3 percent of total proteins. 4 times of Flour
- 300mg ascorbic acid. Approximately 6 times that of orange
- 293 mg potassium. 4 times of bananas
- 118mg phosphorous
- 9.1 mg iron

It also contains more of energy, sodium, vitamin A, riboflavin, Thiamin, Niacin, magnesium and antioxidants.

1.2 Statement of Originality

We came up with this project after reading an article about the nutritional value of baobab.

We also got an inspiration from Matty's porridge where Mchicha had been used to fortify grain flour.

1.3 Statement of the problem

A growing number of children in the current society are developing a negative attitude towards consumption of porridge (Basu, 2006). Research has shown that the negative attitude arises from the many components that are included in porridge such as Amaranth and pumpkin seeds hence producing a taste that kids do not like. When children do not take the porridge, they are likely to miss very important nutrients. A growing number of children in Kenya are suffering from the effects of malnutrition due to poverty and food insecurity. The long term effects of malnutrition include poor growth, underweight and difficulties in learning. This affects the social and economic pillars of vision 2030.

Fig 1.1 Malnutrition among young children

1.4 Objectives of the study

1.4.1 General Objective of the study

To prepare and evaluate grain flour enriched with baobab pulp.

1.4.2 Specific Objectives of the study

i. To improve the nutritional content of grain flour.

ii. To improve the shelf life of grain flour.

iii. To provide a cheaper method of fortifying grain flour.

1.5 Research Hypothesis

There is no much nutritional value in grain flour consumed by the children of ages 4-8.

1.6 Research question

i. Is there any much nutritional value in grain flour consumed by the children of ages 4-8?

ii. Does fortification improve the shelf life of grain flour?

iii. Is the proposed method of fortification in this study cheaper?

1.7 Significance of the study

From this project, the outcomes are:

i. The nutritional quality of grain flour will be improved.

ii. The shelf life of grain flour is going to be increased.

iii. Value addition of grain flour products is affordable and of great importance due to the trend of consumption.

1.8 Organization of the study

The study is divided into five chapters. Chapter one brings out the introduction to this study. This chapter will include the background of the study, the statement of the problem, the research objectives, the hypothesis, the significance, the scope and the limitations of the study. Chapter two will entail the Literature review of the study Chapter three of the study will have the research methodology of this study. Chapter 4 will include the Data analysis and discussion while chapter 5 will entail the conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter is divided into three parts which include the introduction and the empirical literature review, in order for the research gaps to be unfolded, hence providing a knowledge gap for the current study.

2.2 Empirical Literature Review

WHO (2012) noted that while there is possibly 100,000 different edible plants in the world, so few are commercialized due to incomplete safety assessments, poor shelf life and the unavailability of the material for commercial production. Recently, a new botanical to the west seems to have found a reasonable solution to these problems with its use being imminent into the European Union and the USA market place.

Adolphe, Dahl, Whiting and Tyler (2006) noted that the baobab tree, *Adansonia digitata*, is a member of the Bombacaceae family which consists of around 20 genera and around 180 species. This deciduous tree was originally located in South Africa, Botswana, Namibia, Mozambique and Zimbabwe (Chapman, 2006), but it can be found in most countries within the African continent. Export by traders means the baobab tree is also common in America, India, Sri Lanka, Malaysia, China, Jamaica and Holland (Keller, 2004).

Chapman (2006) first highlighted the presence of organic acids in the baobab fruit pulp. These included citric acid, tartaric, malic, succinic and ascorbic acid. A later report from WHO (2012) confirmed the observations of Chapman (2006), when they showed that the pulp contained ascorbic acid, tartaric acid, mainly water soluble pectin and the elements of iron and calcium.

Gibson (2005) noted that the pulp of the baobab fruit had numerous uses by the indigenous people of Africa. The researcher noted that the fruit was eaten as a sweet and was also used to make ice cream. In Sudan, a refreshing drink called “gubdi” is made from the fruit pulp and cold water to preserve the vitamins.

According to Miller (2006), Baobab pulp has been determine to be generally recognized as safe (GKAS), consistent with section 201 (5) of the Federal Food, Drug and Cosmetic Act. This determination is based on scientific procedures as described in the following sections under the conditions of its intended use in food. Therefore, the use of baobab fruit pulp in food, as described below is exempt from the requirement of premarket approval. In the year 2008, the EU authorized the use of baobab dried fruit pulp as a safe ingredient in food products and in 2009, it was granted GRAS status in the United States.

CHAPTER THREE

METHODOLOGY

3.1 Requirements and Ingredients

- Baobab pulp powder
- Grain flour
- Mixing spoon
- Basin
- Seaver
- Pestle and mortar
- Distilled water
- Sodium hydroxide
- Copper (II) sulphate solution
- Iodine solution
- Test tube
- 2, 6-dichlorophenolindophenol (DCPIP)

3.2 Procedure

3.2.1 To prepare Baobab Pulp Powder

- Using a hacksaw, cut the baobab fruit and split it into two.
- Remove the pulp and separate the red fibres.
- Put the pulp in a pestle and grind using the mortar to separate the pulp powder from the seeds.
- Seave to collect fine powder

Fig 3.1 Baobab fruits and powder

3.2.2 Procedure for Grain Flour fortification

Mix the pulp powder and the flour at a ratio of 1: 2 respectively.

Pack the resultant mixture in a tight container or enclosed packet.

3.3 Limitations and Constraints

The limitation is that baobab trees are only found in a few parts of the country. To grow baobab trees for production of the fruit pulp, it will take 20 to 30 years. Baobab is not a fast maturing plant. Urgent impact or fortification using baobab fruit pulp powder rely on the existing plants available.

3.4 Merits

- Baobab is a preservative therefore increasing the shelf life of the fortified grain flour.
- Baobab is an antioxidant to improve the body immune system.
- Baobab is one of the nutritive plants identified by scientists. This improves the nutritional value of the grain flour.
- Baobab is available in the ASAL (Arid and Semi-arid lands) where malnutrition is common due to food insecurity.

3.5 Applications

The grain flour is used to prepare porridge, ugali flour for ugali meal and wheat flour which is used for various pastries.

3.6 Observation

It is observed that the children who take “Mabuyu”, baobab pulp that are flavored are always very healthy, energetic and intelligent.

The acidity of the baobab makes the resultant flour acidic. When food test is done, it shows that ascorbic acid and proteins are present.

3.7 Precautions

- Store the flour in a cool dry place away from direct sunlight.
- Mix the ingredients in the correct ratio.

3.8 Demerits

Because of the acid composition, the flour cannot be used for weaning small babies.

3.9 Effect of change on Parameters

Baobab pulp can also be used to fortify drinks and milk. When it is used in milk, it causes coagulation because of the citric acid.

In the preparation of the flour, if the pulp powder used is more, the resultant flour becomes very weak (if mixed with water, it becomes too dilute).

CHAPTER FOUR

DATA COLLECTION, ANALYSIS AND DISCUSSION

4.1 Data collection

This chapter discusses the methods used in data collection. Data was collected by carrying out nutritional tests and shelf life experiments on the fortified grain flour and unfortified one (control experiment). These experiments were carried out in the nutritional laboratory of the Aga Khan Medical Centre **Kisii, Kenya.**

Grain flour was fortified with baobab fruit pulp powder.

The baobab pulp was mixed with the grain flour in the ratio of 1: 2 respectively at 0%, 10 %, 20%, 30% and 40 % as stipulated in Table 1.

Table 4.1: Formulation of enriched Flour with baobab pulp.

Sample	Grain Flour (%)	Baobab pulp (%)
A	100	0
B	90	10
C	80	20
D	70	30
E	60	40

The following experiments were carried out:

4.1.1 Foaming test

Two grams of baobab powder were dissolved in 100 ml of distilled water and blended at high speed for 1 minute. The volume was measured and foaming capacity was calculated.

The formula used for calculation is:

$$\text{Foaming capacity} = \frac{V2-V1}{V1} \times 100$$

Where V1=initial volume

V2=Final volume

4.1.2 Determination of moisture content

Two grams of the powder were weighed and put in a moisture extraction oven. The difference in weight was calculated as a percentage of the original sample (Agac, 2003).

$$\text{Percentage moisture} = \frac{X2-X1}{X1} \times 100$$

Where X1= Weight of the sample before drying

X2= Weight of the sample after drying

4.1.3 Determination of protein content

Proteins in the samples were determined by Kjeldahl method. 1 g of samples was introduced in digestion flask. 10 ml of concentrated H2SO4 and 8g of digestion mixture of K2SO4: CuSO4 (8:1) was added.

The mixture was transferred to 100 ml volumetric flask and volume topped up using distilled water.

The percentage of protein was calculated using the formulae (Agac, 2003).

$$\text{Nitrogen} = (V1-V2) \times N \times D \times 0.014 \times \frac{100}{V} \times \frac{100}{S}$$

Where V1= Titer for the sample (m1)

V1= Titer for the sample (m1)

S=weight of sample taken (g)

F= Factor of standard HCl solution

N= Normality of HCl solution (0.002)

D=Dilution of sample after digestion

V=Volume of diluted digest taken for distillation (10 ml)

0.014= mill equivalent weight of Nitrogen

Protein %= Nitrogen X protein factor

In the school laboratory, the following method was used:

Add 2ml of Baobab solution in a test tube. To the same test tube, add 1ml of sodium hydroxide followed by 1ml of copper (II) sulphate solution to it. Shake the test tube gently to mix the ingredients thoroughly and allow the mixture to stand for 4 – 5 minutes. If there is the appearance of bluish- violet color, it indicates the presence of protein.

4.1.4 Determination of fiber content

Two grams samples were put into 200ml of 1.25 % of H_2SO_4 and boiled for 30 minutes. The solution and content were then poured into Buchner funnel equipped with muslin cloth and secured with elastic band. This was allowed to filter and residue was then put into 200ml boiled NaOH and boiled for 30 minutes. It was filtered and residue obtained. The fiber content was calculated after weighing the residue.

$$= W1 = \frac{W2}{W3} \times 100$$

Where:

W1= weight of sample before

W2= weight of sample after

W3= weight of original sample

4.1.5 Determination of carbohydrate content

The content of total carbohydrates was calculated by subtracting the sum of moisture, protein, fat and fiber from 100 (Agac, 2003).

In the school laboratory, the following method was used:

Add 2ml of Baobab solution into a test tube. Add 2ml of iodine solution into the same test tube. Shake the test tube gently to mix the ingredients thoroughly. If there is the appearance of blue-black color, it indicates the presence of starch.

4.1.6 Determination of Vitamin C content

Vitamin C determination was done according to the method described by Vikram, Bamesh and Prapulla (2005). 1g of the sample was mixed with 30 ml of metaphosphate acid and centrifuged at 10,000 revolutions per minute for

10 minutes at 4^0C in a refrigerated centrifuge. Filtration was done and the filtrate was divided with 1 ml of 0.8% metaphosphoric acid and filtered. The concentration was calculated from the standard graph in mg/100g.

In the second type of experiment, all the samples were left in a dark place for 3 weeks and the number of E-coli confirmed. Serial dilutions in the ratio of 1: 10 were prepared using peptone water. The dilution was shaken by rotation and tilting. Small drops of each sample was put in a sterilized violet bile agar plates for E-coli test. The plates were incubated at 37^0C for 24 hours then examined for colonies appearing on the medium, which were then counted.

In the school laboratory, the following method was used:

Add 2ml of 2, 6-dichlorophenolindophenol (DCPIP) into a test tube. Add 2ml of Baobab solution into the same test tube. DCPIP loses its color in the presence of ascorbic acid (vitamin C).

4.2 Data Analysis and Presentation

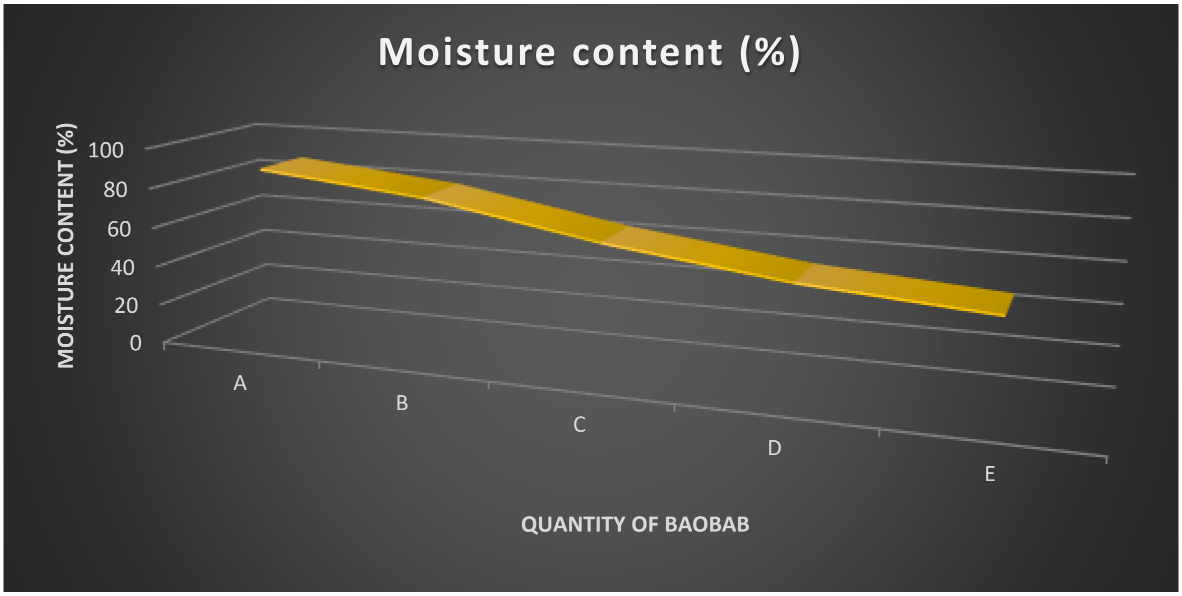
This chapter presents the findings of the experiments and analyze them:

4.2.1 Moisture content

Table 4.2 Moisture content in the samples

Sample	Moisture content (%)
A	87.82
B	79.43
C	64.31
D	53.28
E	47.13

Fig 4.1 Line graph showing the effects of baobab pulp powder on the moisture content of Grain flour

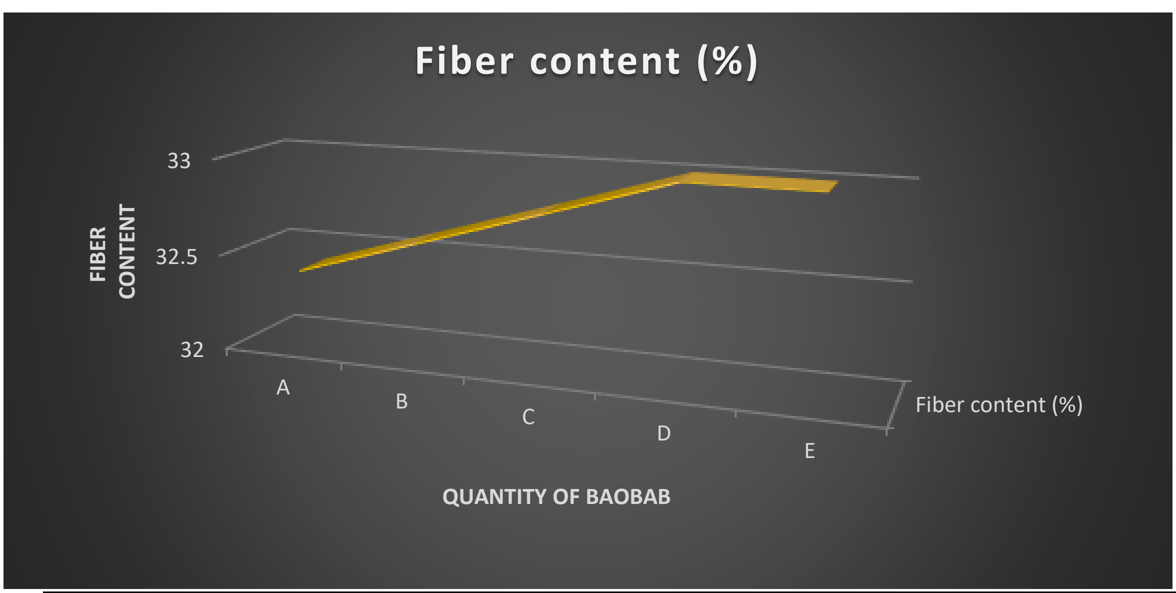


4.2.2 Fiber content

Table 4.3 Fiber content in the samples

Sample	Fiber content (%)
A	32.4
B	32.6
C	32.8
D	33.0
E	33.0

Fig 4.2 Line graph showing the effects of baobab pulp powder on the Fiber content of Grain flour

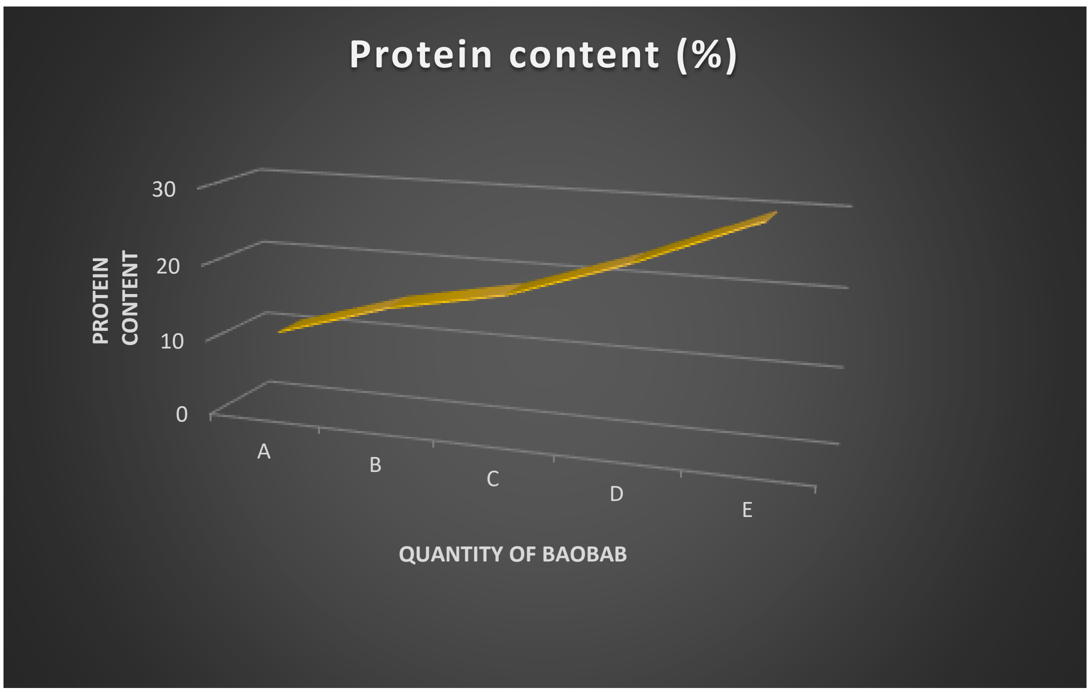


4.2.3 Protein content

Table 4.4 Protein content in the samples

Sample	Protein content (%)
A	10.7
B	15.3
C	18.3
D	23.5
E	29.7

Fig 4.3 Line graph showing the effects of baobab pulp powder on the Protein content of Grain flour

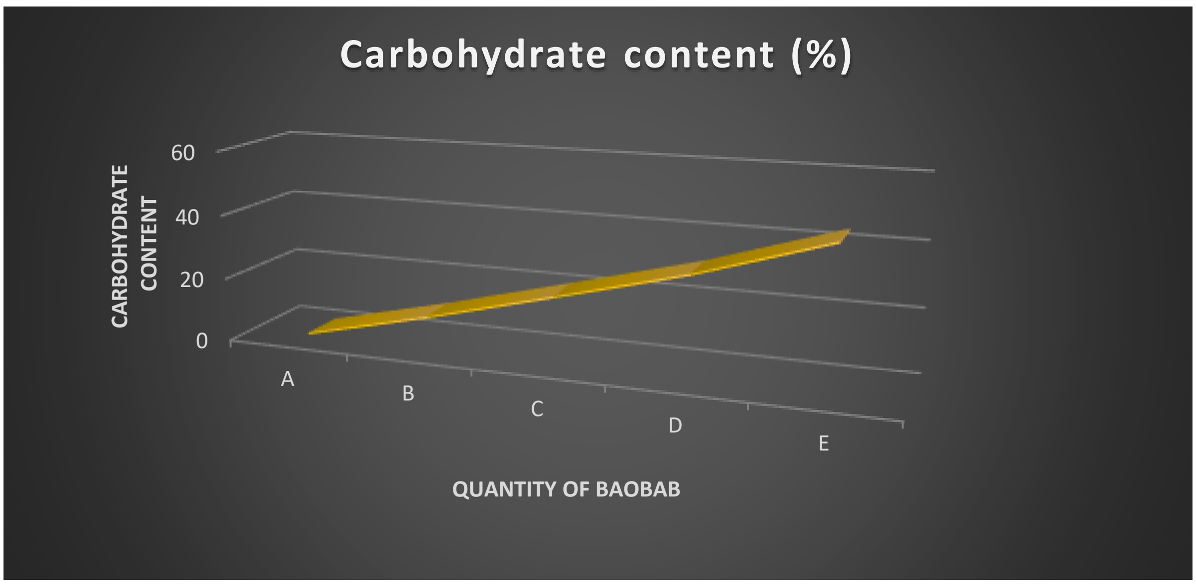


4.2.4 Carbohydrate content

Table 4.5 Carbohydrate content in the samples

Sample	Carbohydrate content (%)
A	0.8
B	10.3
C	20.7
D	31.3
E	44.1

Fig 4.4 Line graph showing the effects of baobab pulp powder on the Carbohydrate content of Grain flour



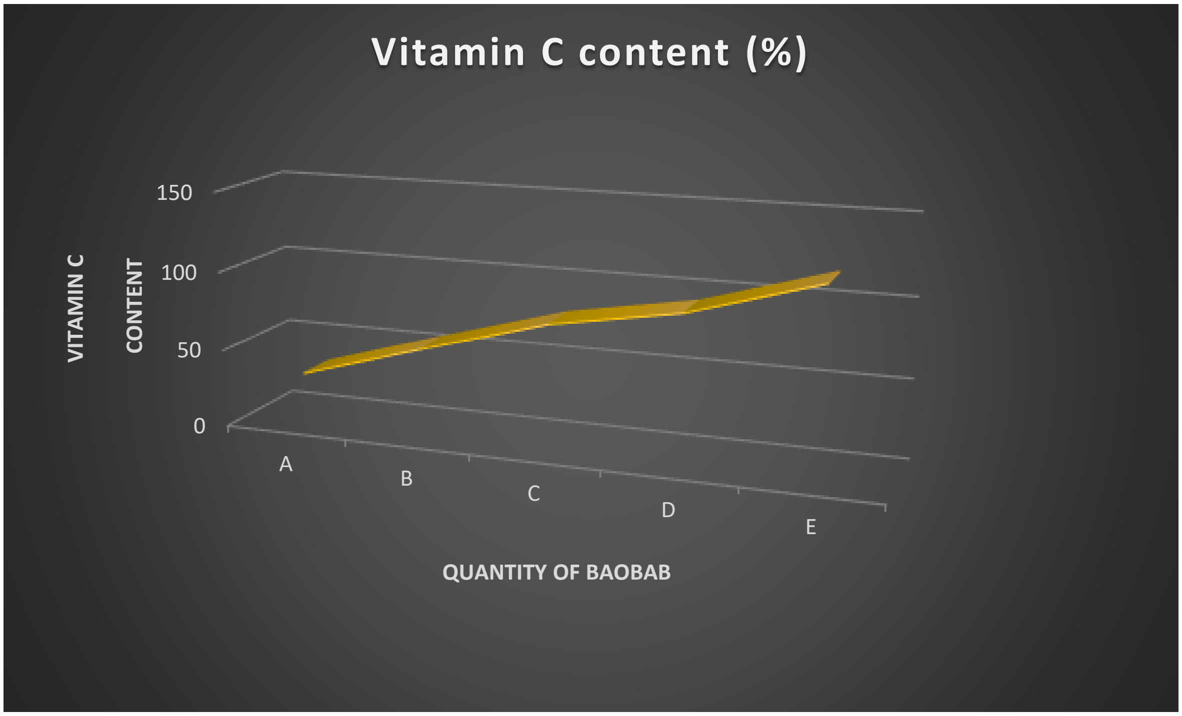
4.2.5 Vitamin C content

Table 4.6 Vitamin C content in the samples

Sample	Vitamin C content (%)
A	32
B	56
C	79

D	93
E	117

Fig 4.5 Line graph showing the effects of baobab pulp powder on the Vitamin C content of Grain flour

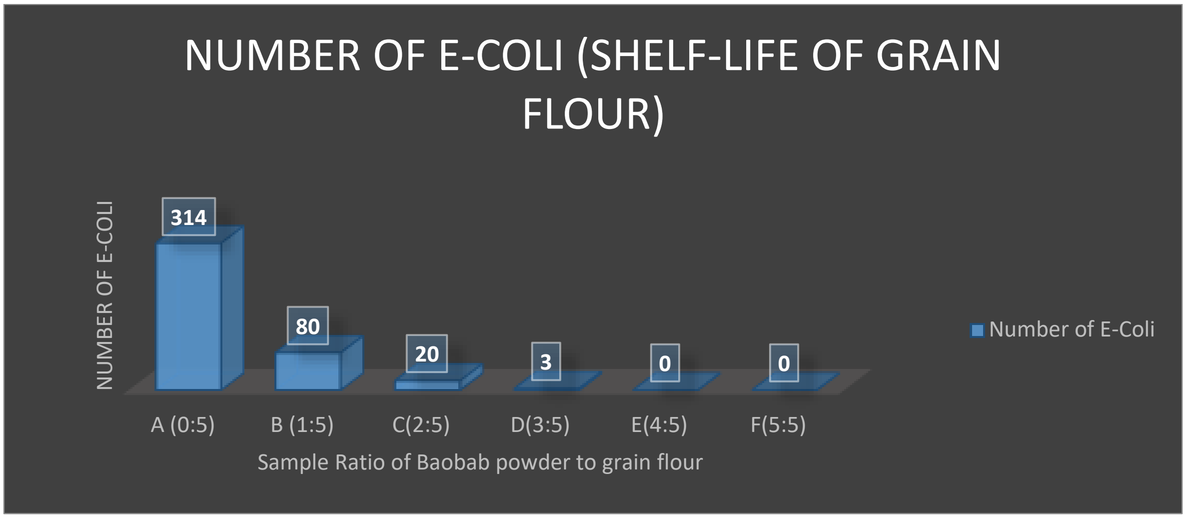


4.2.6 Number of E-Coli (Testing the shelf life of Baobab)

Table 4.7 Number of E-Coli in the Samples after 3 weeks (Testing the shelf life of Baobab)

Sample Ratio of Baobab powder to grain flour	Number of E-Coli
A (0:5)	314
B (1:5)	80
C(2:5)	20
D(3:5)	3
E(4:5)	0
F(5:5)	0

Fig 4.6 Number of E-Coli in the Samples after 3 weeks (Testing the shelf life of Baobab)



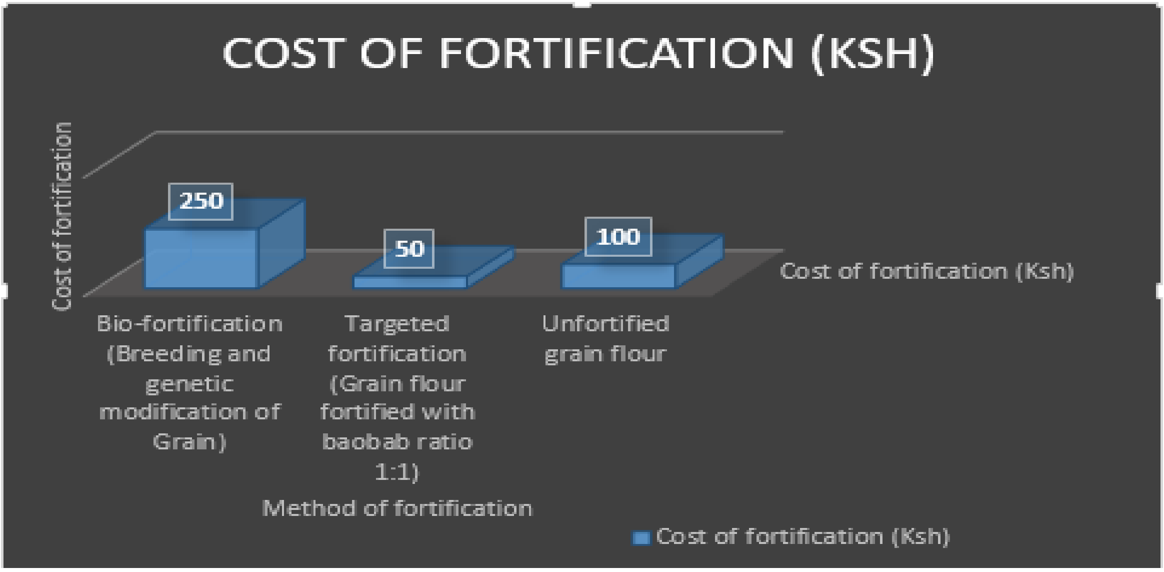
Baobab is a preservative as there is a significant decrease in the number of E-Coli as the quantity of baobab pulp powder increases which proves that it increases the shelf life of the flour.

4.2.7 Cost of fortification

Table 4.8 Cost of fortification

Method of fortification (500g of flour)	Cost of fortification (Ksh)
Bio-fortification (Breeding and genetic modification of Grain)	250
Targeted fortification (Grain flour fortified with baobab ratio 1:1)	50
Unfortified grain flour	100

Fig 4.7 Cost of fortification



Baobab is a cheaply acquired therefore lowers the cost of grain flour. However Bio-fortification is expensive and therefore increases the cost of grain flour as shown above in Table 4.8 and fig 4.7.

4.3 Variables

According to Creswell (2003), a variable is a measurable characteristic that could change and affect the end result in a study. Study variables are commonly independent and independent.

4.3.1 Independent Variables

In this project, the independent variable is:

- The quantity of baobab fruit pulp powder used in fortification.
- Sample Ratio of Baobab powder to grain flour
- Method of fortification

4.3.2 Dependent Variables

In this project, the dependent variable are:

- moisture content, protein content, fiber content, carbohydrate content, vitamin C content
- Number of E-coli which is determined by the quantity of baobab fruit pulp used.
- Cost of fortification

4.4 Data Discussion

The first test was a foaming test which determines how baobab powder can form in the flour without creating sediments.

The results in Table 4.2 or Fig 4.1 shows how the moisture content of the flour decreases with the addition of more powder. This shows that baobab contains gluten which causes the flour to thicken.

Baobab adds fiber value, although in minimal amounts as shown in Table 4.3 or Fig 4.2. Fig 4.3 represents data analyzed in table 4.4. It is established that there is an increasing trend of protein added to the flour as the quantity increases. Baobab contains carbohydrate which is important for energy. As the amount of baobab pulp increases, the carbohydrate content also increases as shown in Table 4.5 or Fig 4.4. Baobab also adds more vitamin C to the flour as shown in Table 4.6 or Fig 4.5

Baobab is a preservative as there is a significant decrease in the number of E-Coli as the quantity of baobab pulp powder increases which proves that it increases the shelf life of the flour. Baobab is a cheaply acquired therefore lowers the cost of grain flour. However Bio-fortification is expensive and therefore increases the cost of grain flour.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From the data, it was concluded that baobab improves the nutritional content of the flour. Baobab adds fiber value, although in minimal amounts. It was also established that there is an increasing trend of protein added to the flour as the quantity increases. As the amount of baobab pulp increases, the carbohydrate content also increases. Baobab also adds more vitamin C to the flour. Baobab is a preservative as there is a significant decrease in the number of E-Coli as the quantity of baobab pulp powder increases which proves that it increases the shelf life of the flour. Baobab is cheaply acquired therefore lowers the cost of grain flour. However Bio-fortification is expensive and therefore increases the cost of grain flour. With this data, the hypothesis has been proved and all the specific objectives have been achieved.

5.2 Recommendation

The study recommends further analysis and tests on the fortified flour to prove if other nutrients which are not tested in this report are present. The study recommends investigation on the influence of temperature, time and PH on the final fortified flour.

5.3 Future Adjustment and Linkage to emerging Issues

- In future, we look to carry out more tests and experiments to prove the presence of other nutrients. We also look to conduct a study on the side effects of baobab.
- This project aims at reducing malnutrition diseases like Kwashiorkor and marasmus which have been emerging issues up until recently.

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APPENDICES

APPENDIX I: LETTER TO THE RESPONDENT

Dear Respondent,

I am currently a teacher at St Angela Sengera Girls' High School, Kenya. My Science club students are currently carrying out a research study on a project whose topic is:

"BAOBAB FLOUR TECHNOLOGY".

I therefore request for your information and cooperation in this exercise. All information will be treated with confidentiality.

Yours with regard

DR. DENNIS OSORO MARANGA
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