DEVELOPMENT OF FRANKFURTER SAUSAGE USING SPIDER PLANT AS AN ALTERNATIVE FILLER AND EXTENDER

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DECLARATION

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NAME…….

SIGNATURE: …….. DATE……..…

CERTIFICATION

This project has been submitted in partial fulfilment to the requirements for the undergraduate Degree, Bachelor of Science in Food Science and Technology University of Nairobi with my approval as the University supervisor.

NAME…….

SIGNATURE: …….. DATE……..…

DEDICATION

To my mum, dad, brother, sister and my uncle, Evans; I owe this to you.

ACKNOWLEDGEMENT

Foremost, I thank the Almighty God who has seen me through the hardest and pleasant of times. I thank my parents for their non-questionable trust they have laid on me all through, of which I have not disappointed.

Special thanks to my supervisor, Dr. Catherine Kunyanga who is primarily the reason I opted for meat processing option.

My classmates have been very much supportive all through the epic, lengthy four year course. Sincerely, I can't think of a better hardworking, intellectual and visionary lot.

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ABSTRACT

This project seeks to develop a sausage rich in crude fibre and antioxidant levels. Sausages in the market are devoid of these important nutrients. The risk is accumulation of cholesterol which can lead to cardiovascular diseases as well as cancer due to low fibre intake.

Sausages of different ratios of spider plant powder and corn flour were developed and acceptability levels analyzed by ANOVA. Laboratory analysis was also done to determine the levels of vitamin C, E and beta carotene in the spider plant and the formulated sausages. Shelf life and water holding capacity tests were also done for the products.

1 INTRODUCTION

1.1 Background Information

The word ‘sausage’ is derived from a Latin word, s*alsu*s, which means salted. Manufacture of sausage began many centuries ago and the industry is expanding with modifications being done on the basic sausages in terms of ingredients used. Sausage was initially common in China, Greece and Rome where it was mentioned by 600-500 BC. This is evidenced by frequency of occurrence of the word sausage in Greek writings. In Rome it became popular for festive occasions that it was placed under the ban of the early church.

Sausage making was a way of preserving and transporting meat in ancient times as there were no refrigeration facilities. Dry sausage was made as a result of discovery of spices that enhanced flavor and preserved the meat. Fresh and dry sausages were produced based on available ingredients and climate. Cold climate areas such as Northern Europe were able to keep fresh sausage without refrigeration during winter. They developed a smoking process to preserve meat during warmer seasons. Hotter climates in South Europe developed dry sausage which did not require refrigeration. Frankfurter sausage originated from German and has been known since the 13^{th} century.

Casings used were prepared from parts of the intestinal tract of cattle, sheep or hogs.

Sausages are comminute meat products generally recognized as emulsified, stuffed, linked, smoked and cooked meat products.

Sausage production generally involves mincing of meat and fat followed by mixing them with spices at low temperatures maintained by use of ice. Emulsification is done and the sausage is transferred to a stuffer from where it is extruded into casings. The stuffed casings are then linked and subsequent processes are done depending on the sausage type. For frankfurter, smoking is done at 65°C for 45-60 minutes to obtain golden brown color, cooking in the smoke cabinet at 75°C to obtain an internal temperature of 68°C for 12-20 minutes, cooling to 20-25°C and then vacuum packed.

During smoking process, the temperature, relative humidity and smoke density are monitored in order to obtain good quality sausages. Smoking temperature is crucial due to botulism threat. It

should exceed 60°C to eliminate *Clostridium botulinum*which grows in the anaerobic environment created in the interior of sausage and thrives in 4-60°C range in the smoke house and subsequent ambient storage.

The other determinants of sausage quality include;

Emulsion –the protein and water of the meat mixture form a matrix that encapsulates the fat portion. Myosin in meat acts as the primary emulsifying agent. Addition of salt and mixing of the ingredients releases myosin from the muscle fiber. This is due to disruption of the fibers that contain myosin.

Fillers and binders – increase mineral levels in the final product, improve color, improve binding properties, improve slicing properties and alter flavor.

Frankfurter sausage is commonly known as smoky. Pork and beef are mostly used in its production. The sausage is often high in sodium nitrate, fat and nitrite content, ingredients containing chemicals believed to cause cancer. An American Institute for Cancer Research (AICR) report showed that consuming 50g serving of processed meat increases risk of colorectral cancer by20%. According to AICR, the average risk of colorectral cancer is 5.8% but 7% when a hot dog is consumed daily over years. (*en.wikipedia.org/wiki/Hot-dog)*

High cholesterol levels in meat with low dietary fiber also increase chances of cardiovascular diseases and cancer.

1.2 **Problem Statement**

Sausage is consumed majorly by people in urban areas where indigenous vegetables such as spider plant are rarely consumed. Beef and pork have been shown to contain high cholesterol amounts.The urban people are at a risk of suffering from cardiovascular diseases and cancer due to high fat content and low fiber content of meat.

Free radicals are responsible for ‘oxidative stress’ and often are implicated in expression of several human diseases including diabetes, cancer and cardiovascular diseases.

1.3 **Justification**

Spider plant is rich in the nutrients responsible for antioxidant activity i.e. vitamins C, E and beta carotene (avrd.org).

It is also rich in dietary fiber.

Dietary fiber and antioxidants will help counter the high cholesterol levels in meat thus lower chances of cancer and cardiovascular diseases and reduce oxidative stress. *www.bioline.org.br*

The low protein and high mineral content in spider plant makes spider plant suitable as filler in sausage manufacture. *blogs.worldwatch.org/nourishingthep*

1.4 **General Objective**

To develop an acceptable frankfurter sausage with incorporation of spider plant as a filler and extender.

1.5 **Sub-objectives**

- To formulate an acceptable frankfurter sausage from spider plant powder.
- To analyze vitamin C, beta-carotene and crude fiber content of spider plant powder and that of developed frankfurter sausage.
- To determine the effect of addition of spider plant powder on WHC of sausage.
- To determine acceptability of the products.
- To evaluate shelf life of the modified sausage.

1.6 **Hypothesis**

An acceptable sausage can be developed by incorporating spider plant as filler and extender.

2 LITERATURE REVIEW

2.1 Sausage Production in Kenya

Mutura is the real Kenyan sausage and is sold as a street food. It is produced by stuffing goat intestine wrappers with a combination of ground meat parts and goat blood. The sausage is boiled until it is almost cooked through and then thrown on a grill to dehydrate the meat to give it a sensational smoky taste.

Large scale production of sausages is done by companies such as Kenchic, Farmer's Choice and the Kenya Meat Commission. Beef, lamb, poultry and pork are majorly used. There are attempts by youth groups to use fish and rabbit meat for sausage production.

Both natural and artificial casings are used.

2.2 Production and Consumption of Spider plant in Kenya

Spider plant is generally considered a weed plaguing maize and bean fields in Kenya. It is a green leafy indigenous vegetable whose production and consumption is majorly in rural areas.

It is common in Western Kenya, Nyanza and major urban markets. Spider plant contributes a healthy diet for many rural people and is known by various names including; saga, African cabbage, cat's whiskers, mwangani, chinsaga, saget,spider flower and the scientific name *Cleome gynandra*.

2.3 Uses of Spider Plant

Spider plant is consumed as a vegetable on its own or together with stew and ugali.

It grows all over tropical Africa, Asia and the Americas. It is highly nutritious and is well adapted to many African ecosystems. Spider plant is known to have high levels of beta carotene, 89.6mg/100g vitamin C, 17.5mg/100g protein, 3.11mg/100g fat, 8.1mg/100g iron, 7.8mg/100g zinc, 3.28mg/100g fiber and 3.06mg/100g calcium.*blogs.worldwatch.org.*The vitamin C in spider plant is fairly stable compared to the other vegetables. [*Sreeramuluet al (14)]*

These qualities give spider plant ability to prevent cardiovascular diseases, cancer, common nutritional disorders as a result of iron deficiency which is the world's most widespread nutritional disorder, vitamin A deficiency and the others. The antioxidants also have an anti-ageing effect. The local communities therefore view spider plant as havingneutraceutical value.

Among the communities where spider plant is common, it is fedmajorly to lactating mothers as it is believed to activate milk production, replace lost iron, provide minerals, proteins and vitamins, heal hidden wounds in the body, assist the womb grow back to normal size and help the body expel all the after-delivery from the womb.

2.4 **Role of Binders and Extenders in Sausage Production**

Different ingredients are used in sausage production apart from meat and major categories include binders, fillers and extenders.

Fillers can be cereals, legumes, vegetables, roots and tubers and are used between 2-10%. They serve to increase volume and can as well increase levels of minerals such as iron, magnesium and calcium that are already in meat.A sausage filler is required to be low in protein and high in carbohydrates. (*www.fao.org/…).*

Binders aid in water holding while extenders add volume to sausage.

3 EXPERIMENTAL DESIGN AND METHODOLOGY

3.1 **Materials**

1 kg frozen pork lean grade II

0.4 kg chilled pork fat

0.4 kg ice

0.3 kg ground spider plant

0.3 kg corn starch

Salt and spices

NPS

Polyphosphate

White pepper

Sodium glutamate

Nutmeg

3.2 **Sample Collection and Preparation**

- Sample collection will be done in local markets in Nairobi and the pilot plant**.**

3.2.1 Preparation of Spider Plant

- Separate the edible portion.
- Wash leaves in clean running water.
- Blanch in steam for 4 minutes.
- Oven drying the blanched vegetables.
- Grinding the dried vegetables.

3.3 **Formulation of Frankfurter Sausage using Spider Plant Powder**

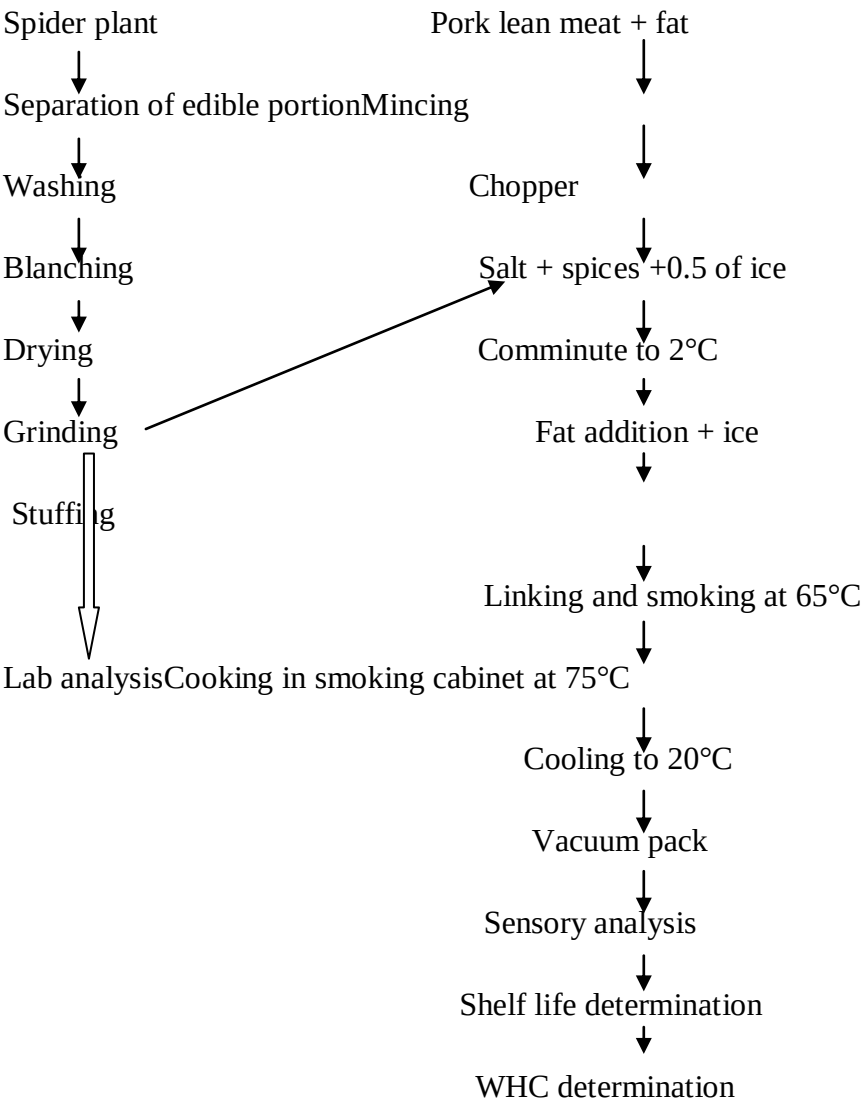

Table 1: Ratio of Ingredients for the Sausages

Material	**Sample A**	**Sample B**	**Sample C**	**Sample D**
Frozen pork lean meat grade II	50%	50%	50%	50%
Chilled pork fat	20%	20%	20%	20%

Ice	20%	20%	20%	20%
Corn starch	10%	6%	2%	0%
Spider plant powder	0%	4%	8%	10%

3.4 **Analysis**

- Determination of ascorbic acid by AOAC 2005 method
- Determination of beta-carotene by method No.44 of IFFJP of 1972.
- Determination of CF by Acid Detergent Residue method.
- Determination of water holding capacity of developed sausages.
- Sensory analysis of products.

3.5 **Acceptability Studies**

- **Evaluation Chart**

5= Like very much

4= Like slightly

3= Neither like nor dislike

2= Dislike slightly

1= Dislike very much

- ANOVA

3.6 **Shelf life Determination**

By accelerated method.

3.7 **Water Holding Capacity Determination**

Cut each sausage cross-sectionary.

Press against an adsorbent paper.

Measure the diameter of the water mark left.

4 RESULTS AND ANALYSIS

Image 1: Sausages after stuffing

Image 2: Sausages after smoking

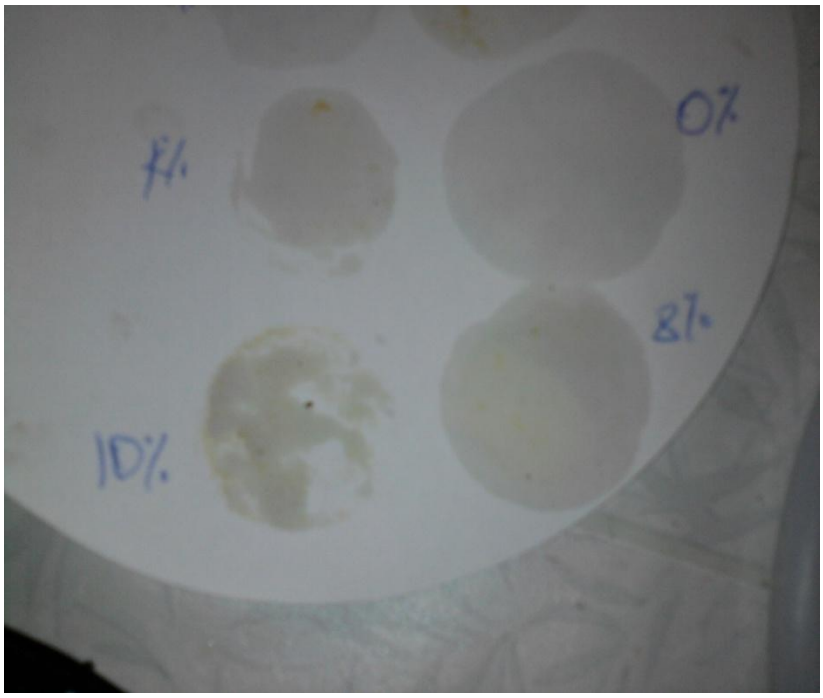

Image 3: Water holding capacity determination

Image 4: Sausages after one week of freezing

4.1 **Table 2: Vitamin C Results and Analysis**

Component	**Spider plant**	**Sample B**	**Sample C**	**Sample D**
Sample weight	2g	2g	2.001g	2.03g
Titre	13.1ml	0.5ml	1.0ml	1.3ml
Vitamin C	1.297mg	0.049mg	0.0989mg	0.129mg
In 100g	64.76mg	2.47mg	4.94mg	6.43mg

Vitamin C=$\frac{VxCx176}{178}$

V=volume of N-brosuccinimide (ml)

C=concentration of N-bromsuccinimide (mg/ml)

4.2 **Table 3: Beta Carotene Results and Crude Analysis**

Component	**Spider plant powder**	**Sample B**	**Sample C**	**Sample D**
Absorbance	0.587	0.058	0.117	0.147
Beta carotene	17120µg/100g	676.67µg/100g	1365µg/100g	1715µg/100g

Beta carotene=Absorbance x$\frac{0.14}{0.12}$x$\frac{100}{25}$x$\frac{50}{2}$ x 100

Sample weight=2g

4.3 **Table 4: Crude Fibre Results and Analysis**

Component	**Spider plant powder**	**Sample B**	**Sample C**	**Sample D**
Sample weight	4.018g	4.023g	4.014g	4.13g
D+CF+GW	36.813g	42.312g	38.148g	36.45g
D+GW	36.51g	42.2664g	38.039g	36.314g
CF content	0.303g	0.048g	0.109g	0.136g
In 100g	75.75mg	11.93mg	27.15mg	32.93mg

D= Dish & GW = Glass wool

4.4 **Table 5: Mean Scores for Sensory Evaluation**

Attribute	**Sample A**	**Sample B**	**Sample C**	**Sample D**
Color	5	4	3	2

Appearance	5	4	3	3
Flavor	4	4	3	3
Texture	5	4	4	4
Taste	5	4	3	3
Overall acceptability	**5**	**4**	**3**	**3**

4.4.1 Analysis of Variance for Organoleptic Analysis

Panelist	**A**	**B**	**C**	**D**
1	5	4	4	2
2	4	3	2	2
3	5	4	4	4
4	5	5	4	5
5	5	4	4	3
6	5	4	5	4
7	4	3	2	2
8	5	4	4	4
9	4	4	2	1
$\sum x$	**42**	**35**	**31**	**27**
$\sum x^2$	**198**	**139**	**117**	**95**
N	**9**	**9**	**9**	**9**

N=36

K=4

i) Correlation factor (CF)=$\frac{(\sum x)2}{N}$

$=\frac{(42+35+31+27)2}{36}$

=506.25

ii) SS Total =$\sum x^2$**-CF**

=(198+139+117+95)-506.25

=549-506.25

=42.75

iii) SS Group = = $\sum (\sum x)^2 / n$ - CF

$=\frac{(42)2}{9}+\frac{(35)2}{9}+\frac{(31)2+}{9}\frac{(27)2}{9}$-506.25

=519.89-506.25

=13.64

iv) SS Error =SS Total –SS Group

=42.75-13.64

=29.11

v) MS Group = SS Group/Df Group

Df Group = k-1

=13.64/3

=4.55

vi) MS Error = SS Error/Df Error

Df Error = N-k

=29.11/33

=0.88

vii) Variance Ratio (VR) = MS Group/MS Error

=4.55/0.88

=5.158

Calculated F (3,33)95% confidence level=6.345

Calculated F>VR

6.345>5.158

Source	Df	SS	MS	F
Total	N-1=35	42.75		
Group	k-1=3	13.64	4.55	5.158
Error	N-k=33	29.11	0.88	

4.5 Shelf life Determination

The sausages were held at room temperature, 55 ˚C oven and frozen for 5 days. They developed off-flavor at the end of the 2nd day and darkened with time at room temperature. In an oven at 55˚C they developed off-flavor on the 2nd day and turned dark on the 3rd day. At freezing temperature they kept fresh.

4.6 Water Holding Capacity Determination

- Sample A had a 64% WHC, B had 80%, C had 66% and D had 77%.

4.7 Discussion

The levels of vitamin C, beta-carotene and crude fiber increased from sample B to sample D due to increase in amount of spider plant used in formulation. This reflects theoretical expectation since the amount of nutrients increases with increase in food sample.

The average acceptability of formulated sausages decreased with increase in amount of spider plant used but was generally liked as the lowest average score was 3. This can be attributed to many panelists being unfamiliar with the spider plant thus less liking. The colour for sample D was most disliked but considering it is a new product it was not badly off. Some African sausages are actually darker than this.There is a significant difference between samples A, B, C and D with parameters ranging from colour, appearance, taste, aroma and texture. This is proven by the ANOVA result where the F value is greater than the variance ratio. This is a true reflection of the experiment since the sample varied in ratio of spider plant to corn flour.

The sausages that were held at room temperature and oven at 55˚C for 5 days developed off-flavor and darkened with time. Those at freezing temperature kept fresh. This indicates longer shelf life can be attained by storing at low temperature.

Sample B had the best water holding capacity of water adsorbed on filter paper. The normal sausage had the least an indication that spider plant powder has a good WHC. It howver does not give a uniform trend since the 8% spider plant sample had a lesser value than 10% yet is lies between the optimum and minimum level.

5 CONCLUSION AND RECOMMENDATIONS

5.1 **Conclusion.**

The spider plant was rich in antoxidants and crude fibre thus suitable to solve problem under study.

The sausages were successfully formulated with spider plant.

The formulated sausages had a better WHC than the normal sausage.

The best acceptable sausage was Bwith 4% spider plant powder.

There is a significant difference between samples A, B, C and D with parameters ranging from colour, appearance, taste, aroma & texture.

The developed sausages had a 1 month shelf life under freezing conditions.

5.2 **Challenges.**

Vitamin C did not give a sharp end point during titration.

Vitamin E levels could not be determined yet it is one of the antioxidants under study due to lack of equipment.

Lack of pork in the pilot plant where I intended to obtain it from.

The pilot plant lacked material essential for product formulation including ice and spices despite assurance that all were available. Product development was therefore postponed.

5.2.1 Way forward

Several titrations carried out and an average taken.

Purchase of pork from Junction shopping centre.

Purchase of spices and making ice for product development.

5.3 **Recommendation.**

Use of better methods such as HPLC for vitamin C and E analysis.

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