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FOOD RESEARCH INSTITUTE

CHEMICAL, MICROBIOLOGICAL AND SENSORY QUALITIES OF FIVE VARIETIES OF GROUNDNUTS

(A Food Research Institute/AgSSIP Technical Report)

by

Phoebe Lokko
Kafui Kpodo
Margaret Otta-Attipoe
Frimpong Adams

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ABSTRACT

Chemical, microbiological and sensory qualities of groundnuts and Dzowe were assessed among 5 varieties namely Chinese, Manipinta, Zinkasie, F-mix and JL-24. The work was carried out under AGSSIP project on peanut. The main objective of this study was to conduct chemical, microbiological and sensory analyses on the five varieties of groundnut produced and their products. It is hope that the variety as well as the least contaminated products would be identified in other for further studies into storage period of the varieties of groundnut as well as the shelf life of their products would be carried out. It is recommended that studies should be carried out to establish storage period as well as the shelf life of the various products to eliminate chronic chemical and microbial contaminants. It is recommended that cleanliness of drying facilities as well as personal hygiene of individuals handling the products should be ensured to minimize microbial contaminants. The findings from this study should be made available to the general public, professionals as well as individuals in the food industries which use groundnut as raw material in product development in order to obtain high quality products to increase productivity and profit margin.

1.0 INTRODUCTION

Groundnut (*Arachis hypogea*) is a highly acceptable food item in Ghana, It has been shown to be high in nutrients and also lower peoples risk of developing chronic diseases. Groundnuts are good sources of proteins, essential fatty acids, fibre, vitamin E, abd minerals such as potassium, magnesium, zinc and copper. The high level of unsaturated fat found in groundnuts may be partly responsible for the observed association between frequent nut consumption and coronary heart disease. hence improvement in the quality of existing groundnut products and developments of new products need to be addressed.

Ghanaians, traditionally, consume groundnuts boiled, roasted, raw, and in processed forms such as groundnuts paste, candies and milk. Groundnuts are also used as ingredients in traditional dishes such as groundnut soup, groundnut and palm soup, groundnut and nkontomire soup, dzowe, Oto, saabo, cutlets and in confectionery and bakery products.

Savanna Agricultural Research Institute (SARI) of the Council for Scientific and Industrial Research produced different groundnut varieties with the aim of providing the know how for farmers to increase productivity, thus getting the best out of the season's toil. Also, to serve as an excellent protocol for would-be investors in large-scale groundnut production who have little or no knowledge of groundnut cultivation Seventy to eighty percent of the nations groundnut is produced in the Northern part of Ghana. The crop does well in well drained friable sandy loam with at least 550 mm of rainfall. Since groundnut is subterranean crop, it is essential the land is loosened by ploughing, bedding or the use of animal traction to loosen the soil.

In Ghana, groundnuts are often stored in the prevailing warm humid temperature conditions in the jute sacks, clay or mud silos, clay pots or straw baskets. . They are stored for many months to be released for sale during the lean season. The storage conditions are ideal for rapid proliferation and growth of bacteria, moulds and yeasts. In such conditions where aflatoxigenic moulds are found on the groundnuts, stimulation of the production of aflatoxins may occur. Also, groundnut pastes found in markets are produced from different varieties of kernels. Microbiological status of these pastes are dependent on the quality of the groundnut kernels used in the production. Factors that may add to the level of mould and yeast infestation include the mode of handling, storage conditions, the cleanliness of the utensils/jute sacks used, the hygienic practices of the handlers, among others.

In line with the above background, Chemical, Microbiological and Sensory analysis on five varieties of groundnut produced were conducted.

1.1 Objectives

1. To produce and characterize five varieties of groundnuts
2. To conduct chemical, microbiological and sensory analysis on the varieties of groundnut produced and their products.
3. Document and disseminate the results at workshops.

1.2 Materials and Methods

Production

The materials and methods for groundnut production have been compiled in a handout on **Ground Nut production Techniques** by Adams Frimpong (2002)

Chemical analysis

Proximate analysis was carried out the five varieties of groundnuts using Official Methods of Analysis-AOAC- 15th Edition 1990 to detect moisture, fat, ash and protein levels of each groundnut variety. Percentage carbohydrate including fiber and energy content of **dzowe** was also determined

Microbiological analysis

Groundnut paste samples were prepared from the varieties obtained for microbiological analyses.

Standard microbiological techniques were employed to analyze the samples for aerobic plate counts, mould and yeast counts, coliform counts, detection and enumeration of *E. coli*, *Staphylococcus aureus* and *Bacillus species*.

- a. Aerobic plate counts
Standard method NMKL 86 (1999) of the Nordic Committee on Food Analysis.
- b. Mould and yeast counts
Standard method 7954 (1987) of the International Standards Organization.
- c. Coliform counts
Standard method NMKL 44 (1995) of the Nordic Committee on Food Analysis
- d. *E. coli*
Standard method NMKL 125 (1996) of the Nordic Committee on Food Analysis.
- e. *Salmonella species*
Standard method NMKL 71 (1999) of the Nordic Committee of Food Analysis
- f. *Bacillus cereus*
Standard method nmkl 67 (1997) of the Nordic C ommittee on Food Analysis.

g. pH was measured with pH meter.

Aflatoxins analysis

Proximate analysis was carried out using Official Methods of Analysis-AOAC- 15th Edition 1990 to detect the presence of aflatoxins in the five varieties of groundnut samples.

Sensory Evaluation analysis

Plain Roasted Groundnut

The same quantities of the 5 peanut varieties were plain roasted at the same temperature for the same amount of time.

14 well-trained panelists in the different stages of sensory analysis were served whole unpeeled roasted groundnuts.

Ordinary tap water and cream cracker biscuits were given as mouthwash after each sampling.

Dzowe

The 5 peanut varieties were used to prepare Dzowe as a sweet snack. Dzowe is prepared from peanuts, roasted maize meal, sugar, spices and other condiments. The samples were prepared under supervision by a professional Dzowe producer.

14 well-trained panelists were served 5 samples of dzowe prepared from the 5 varieties of groundnut.

Ordinary water and cream cracker biscuits were given as mouthwash after each sampling

The sensory attributes requested for evaluation were Appearance, Taste, Aroma, Texture, Mouthfeel, Hotness, Overall acceptability

2.0 RESULTS AND DISCUSSIONS

2.1 CHARACTERIZATION OF GROUNDNUTS.

The chemical, microbiological and sensory analyses were conducted on the samples of groundnut and their products. Samples of groundnut were also characterized.

Five groundnut varieties namely F-mix, Chinese, Zinkarzie, Manipinta and JL-24 were characterized to in terms days of maturity, potential yield, seed colour, oil content and weigh per 100 seeds. The results are shown in Table 1 below.

Table 1. Characterization of five varieties of groundnuts.

Variety	Days of maturity	Potential Yield (t/ha)	Seed color	Oil content (%)	100 seed weight (g)
F mix	120	2.5	Tan and white	49	52
Chinese	100	2.2- 2.5	Brown	35	39
Zinkarzie	120	2.2	Red	46	62
Mani Pintar	120	2.5- 3.0	Red, brown and white	53	53
JL 24	100	2.2	Light brown	35	40

2.2 CHEMICAL ANALYSIS

Samples of five groundnut varieties coded 1,2,3,4, and 5 were analyzed for moisture, protein, fat, ash and aflatoxins B₁, B₂, G₁ and G₂. The moisture content of the samples ranged from 4.2 - 5.0% fat 47.1 – 51.2%, ash, 2.3 – 2.6% and protein 22.4 to 29.5%. The measured

values for moisture, fat, ash and protein are all within the expected ranges (FAO, 1968). Tables 2 and 3 display the results for chemical analysis of plain roasted groundnut and **dzowe** respectively. However, there were differences in the oil content from SARI's and from FRI which may be due to the different methods used Or the moisture content at the time of analyses.

Chemical analysis revealed that the measured values for moisture, fat, ash and protein are of all five groundnut varieties were within the expected ranges. However, the difference in oil content from SARI'S analysis and that of FRI could be due difference in soil type, weather and time of planting as well as selected seeds which are factors very crucial for groundnut production (Groundnut production techniques, 2002).

Table 2. Chemical analysis of 5 varieties of groundnut

Parameter	F-Mix	Chinese	Zinkazie	Manipinta	JL-24
Moisture (%)	4.6	4.2	4.8	4.6	5.0
Fat (%)	51.2	49.3	50.7	47.8	47.1
Ash (%)	2.3	2.4	2.4	2.4	2.6
Protein (%)	26.7	24.8	28.5	28.7	29.3

Table 3. Chemical Analysis of Dzowe

	Manipinta	Chinese	Zinkarzie	F-Mix	JL-24
Moisture (%)	3.0	2.8	3.1	2.9	3.0
Ash (%)	2.2	2.2	2.0	2.0	2.1
Protein (%)	16.6	16.7	14.6	13.4	16.9
Fat (%)	23.5	20.7	21.9	21.3	22.8
Carbohydrate including fibre (%)	54.7	57.6	59.0	60.4	55.2
Energy /100g	496.7	483.5	491.7	486.9	493.6

2.3 AFLATOXIN ANALYSIS

Aflatoxin Determination

Aflatoxin contamination caused by *A. flavus* and *A. parasiticus* in groundnut is one of the most important constraints to groundnut production in many countries in the West African sub- region. Contamination by mould growth is significantly affected by storage conditions of climate and moisture content of the peanuts under both pre and post harvest conditions.

Aflatoxin analysis shows that all the five samples of peanuts contained aflatoxins at varying levels. F-Mix presented with the highest total aflatoxin level of 5,039 μ ug/kg, which is much higher than the FAO recommended maximum permissible limit of 30ug/kg. The other 4 samples contained less than the recommended maximum permissible amount. (FAO, 1968).

The presence of some level of aflatoxins in all samples could be due to the presence of

Aspergillus niger , mould species, which was present in all the samples as seen in Tables 5 and 6 respectively.

Table 4. Aflatoxin analysis of 5 groundnut varieties

Parameter	F-Mix	Chinese	Zinkazie	Manipinta	JL-24
Aflatoxin B1 (µg/kg)	4,161.5	8.9	0.9	3.5	1.4
Aflatoxin B2 (µg/kg)	878.2	2.3	ND	ND	ND
Aflatoxin G1 (µg/kg)	ND	ND	ND	ND	ND
Aflatoxin G2 (µg/kg)	ND	ND	ND	ND	ND
Total Aflatoxins (µg/kg)	5039.7	11.2	0.9	3.5	1.4

ND= none detected.

2.4 MICROBIOLOGICAL ANALYSIS

Plain roasted groundnut

The 5 groundnut samples were accessed for their microbiological status. Results of Aerobic plate counts, mould and yeast counts, *coliform* counts, *E. coli* count, *Salmonella species*, *Bacillus cereus* count, *Staph. Aureus* count, microscopy, and pH were obtained.

Total viable aerobic plate counts at 30 °C of all varieties did not indicate significant variation and ranged between 1.0×10^4 and 8.3×10^4 cfu/g.

The mould and yeast counts ranged between 1.0×10^2 and 5.1×10^4 cfu/g. predominant moulds were *Aspergillus niger*, *A ochraceus* and *Mucor ssp.* *Coliform* counts were less than 10cfu/g in all the samples except Zinkarzie which had 1.4×10^2 indicating possible faecal contamination due possibly to the drying surface dust etc. The pH values ranged from 6.81 to

6.97. Studies show that survival of mould and yeast causing decreases with increasing acidity. Therefore the high mould and yeast count in Manipinta (5.1×10^4) could be attributed to its relatively lower acidity (pH=6.97). The presence of mould and yeast contaminants in all samples especially Manipinta could be attributed to varying moisture level of the varieties of groundnut hence storage periods and relatively high acidity (pH=6.92) in the case of Manipinta

Table5. Total viable counts, mould and yeast count, coliform count and

***E. Coli* count of the groundnut varieties**

Groundnut sample	Total viable count at 30°C (cfu/g)	Mould and yeast count (cfu/g)	Coliform count (cfu/g)	E. coli count (cfu/g)	pH	Dominant Flora
Manipinta	1.6×10^4	5.1×10^4	< 10	<10	6.97	A. niger, A. ochraceus. Yeasts, Bacillus spp
F-mix	1.0×10^4	2.5×10^2	< 10	<10	6.87	A. niger, Bacillus spp, Micrococci
Chinese	8.3×10^4	1.8×10^4	< 10	<10	6.89	A. niger, A. ochraceus. Bacillus spp Micrococci
Zinkazie	2.3×10^4	1.0×10^2	1.4×10^2	<10	6.92	A. niger, Yeasts, Bacillus spp Gram negative rods
JL-24	3.3×10^4	1.4×10^2	< 10	<10	6.81	A. niger, Mucor spp, Bacillus spp

Dzowe

Five Dzowe samples were accessed for their microbiological status. The aerobic plate count at 30 °C ranged between 5.6×10^5 and 1.2×10^7 cfu/g, the mould and yeast count between 3.0

$\times 10^2$ and 5.1×10^4 cfu/g. Coliform counts ranged between 2.4×10^1 and 1.8×10^3 cfu/g. *E. coli* counts ranged between 5.0×10^1 and 1.4×10^2 cfu/g. *Bacillus cereus* and *Staphylococcus aureus* counts were less than 1.0×10^2 cfu/g while *Salmonella* species were not detected in 25.0 g of any of the samples.

Dominant flora in the samples include Gram-positive sporing motile and non-motile rods, gram-positive cocci, *Aspergillus* species and yeast.

The pH of the groundnut paste ranged from 6.2 – 6.7.

The recommended limit of aerobic mesophiles GSB (1998) and ICMSF (1982) is $< 1.0 \times 10^6$ cfu/g. thus only Dzowe prepared with Chinese qualified.

The mould and yeast counts, specified by both Boards is $< 1.0 \times 10^4$ cfu/g. Again Chinese Dzowe product was within limit.

Dzowe prepared from Chinese was found to have the lowest mould and yeast count as well as aerobic microbes and therefore fell within the GSB and ICMSGF recommended range.

This could again be due to low moisture (2.8) as well as lower acidity levels (6.2) of this Dzowe sample.

The *E. coli* (1.4×10^2) was also high in product prepared with Manipinta. This could be attributed to the preparation surface and the personal hygiene of handlers of the samples. All other tests were within acceptable levels. The product was stored for 4 months and analyses are being conducted on these samples to see if there has been any deterioration.

Table 6. shows the quantitative and qualitative microbial status of the Dzowe samples.

Table 6. Microbial load of course groundnut paste (Dzowee)

<i>Groundnut paste</i>	<i>Aerobic microbes (cfu/g)</i>	<i>Moulds & yeasts (cfu/g)</i>	<i>Coliform organisms (cfu/g)</i>	<i>E. coli (cfu/g)</i>	<i>Salmonella species (25g)</i>	<i>Bacillus cereus (u/g) x 10²</i>	<i>Staphylococcus aureus (cfu/g)</i>	<i>pH</i>	<i>Dominant Flora</i>
Manipinta	6.0×10^5	1.4×10^4	1.8×10^3	1.4×10^2	Absent	1.0×10^2	1.0×10^2	6.2	Gram +ve sporing rods, Gram +ve cocci, yeasts
Chinese	5.6×10^5	3.0×10^2	6.0×10^2	5.0×10^1	Absent	1.0×10^2	1.0×10^2	6.2	Gram +ve sporing rods, Gram +ve cocci, yeasts, Aspergillus spp
F-mix	1.3×10^6	2.5×10^4	1.8×10^2	5.0×10^1	Absent	1.0×10^2	1.0×10^2	6.3	Gram +ve sporing motile rods, yeast
Zinkazie	1.2×10^7	4.5×10^4	2.4×10^1	4.0×10^1	Absent	1.0×10^2	1.0×10^2	6.3	Gram +ve sporing motile rods, Yeasts, Aspergillus spp
JL-24	4.0×10^6	5.1×10^4	1.7×10^2	8.0×10^1	Absent	1.0×10^2	1.0×10^2	6.7	Gram +ve sporing rods, yeasts

2.5 SENSORY EVALUATION STUDIES

Sensory evaluation analysis was carried out to ascertain the most preferred and the least preferred snack variety.

Plain roasted groundnut

Coding on plain roasted groundnut

Code	Variety
222	Manipinta
604	F-mix
911	Chinese
777	Zinkazie
538	J-L 24

Table7. Mean sensory scores for plain roasted groundnut

Attributes	<i>Manipinta</i>	<i>F-mix</i>	<i>Chinese</i>	<i>Zinkarzie</i>	<i>JL-24</i>
Appearance	7.4 ± 1.2	6.6 ± 0.8	7.9 ± 0.6	7.4 ± 0.9	8.3 ± 0.5
Colour	7.2 ± 1.1	7.1 ± 0.9	8.1 ± 0.5	7.5 ± 0.9	8.2 ± 0.4
Nutty	7.2 ± 0.8	6.9 ± 0.8	7.9 ± 0.9	7.4 ± 0.9	7.9 ± 0.8
Flavour					
Taste	6.7 ± 0.82	6.7 ± 0.8	8.0 ± 0.9	7.2 ± 1.1	8.0 ± 0.6
Sweetness	6.5 ± 1.1	6.8 ± 0.9	8.0 ± 0.9	7.2 ± 1.1	7.8 ± 0.7
Crunchiness	7.4 ± 0.7	7.7 ± 0.7	7.7 ± 0.8	7.5 ± 1.1	7.5 ± 0.6
Aroma	6.8 ± 0.6	6.8 ± 0.9	7.9 ± 0.7	7.1 ± 0.8	7.8 ± 0.9
Mouth feel	6.8 ± 0.86	7.0 ± 0.9	7.8 ± 0.9	7.4 ± 1.0	8.0 ± 0.6
Overall acceptability	7.1 ± 0.6	6.7 ± 0.9	7.9 ± 0.6	7.4 ± 0.9	8.1 ± 0.5

Hedonic Scale

The interpretation of the scores using the points 9-1 means 9 is like extremely, 8 means like very much, 7 indicates like moderately, 6 is like slightly, 5 shows neither like nor dislike, 4 dislike slightly, 3 dislike moderately, 2 means dislike very much and 1 shows extreme dislike for the product.

Appearance

Generally, the appearances of five varieties are well accepted. The panelists themselves peeled the nuts to enable them see the whole nut without splitting. The least score is 6.5.

Colour

The results indicated that colour was liked very much.

Nutty Flavour

The nutty flavour in all the varieties was accepted. The results did not show any dislike for any at all.

Taste

Results show that apart from 222 and 604 the taste were liked very much. There were comments about slight bitter aftertaste especially in 604.

Sweetness

Sweetness was highest in sample 911 and least in sample 222. The rest of the samples appreciated well with each other with scores ranging from 7.8-8.

Crunchiness

There was no significant change in the crunchiness of the varieties. They all scored between 7.4 and 7.8, which shows that they were all crunchy.

Aroma

The most preferred aroma came from sample 911. Other varieties also did not show any dislike however.

Mouthfeel

Mouthfeel was liked on the average moderately.

Overall acceptability

The overall acceptability of the 5 samples ranged from 6.7 to 8.1 showing no adverse findings in any case.

Conclusion: All the varieties were liked but JL- 24 stood out impressively in all the attributes of the roasted nuts.

Dzowe

The 5 peanut varieties were used to prepare Dzowe as a sweet snack. The peanut product was chosen because it has export potential and many people enjoy it. It is also quite nutritious and very high in energy; Dzowe is prepared from peanuts, roasted maize meal, sugar and other condiments. The samples were prepared under supervision by a professional Dzowe producer.

14 well-trained panelists were served 5 samples of Dzowe prepared from the 5 varieties of groundnut.

Ordinary water and cream cracker biscuits were given as mouthwash after each sampling

The sensory attributes requested for evaluation were

1. Appearance
2. Taste
3. Aroma
4. Texture
5. Mouthfeel
6. Hotness
7. Overall acceptability

Table 8. Mean sensory scores for Dzowe

Attributes	<i>Manipinta</i>	<i>Chinese</i>	<i>Zinkarzie</i>	<i>F-mix</i>	<i>JL-24</i>
Appearance	7.67 ± 0.76	7.13 ± 1.6	7.66 ± 0.64	7.87 ± 1.09	7.13 ± 1.99
Taste	7.07 ± 1.09	7.20 ± 1.6	7.07 ± 0.99	7.60 ± 0.77	7.20 ± 1.01
Aroma	7.07 ± 0.79	7.07 ± 1.44	7.07 ± 0.90	7.47 ± 1.59	7.07 ± 0.96
Texture	7.47 ± 0.52	7.07 ± 1.16	7.47 ± 1.42	7.40 ± 1.53	7.33 ± 0.98
Mouth feel	7.33 ± 0.89	7.00 ± 1.41	7.33 ± 0.94	7.40 ± 1.72	7.13 ± 0.99
Hotness	6.93 ± 1.44	7.00 ± 0.85	6.93 ± 1.59	7.13 ± 1.07	7.13 ± 0.92
Overall acceptability	7.20 ± 0.86	6.93 ± 1.166	7.20 ± 1.06	7.47 ± 1.06	7.27 ± 0.88

The panelist did not find any difference in the attributes of Dzowe using the different varieties, showing that the differences disappear during the processing of the nuts which could be due addition of spices.

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 Conclusions

The following were the main findings of the study:

1. It was found that JL-24 was the sample with the highest moisture level and Chinese had the least.
2. Aflatoxin analysis showed that F-mix had the highest total aflatoxins level, which exceeded FAO permissible limit.
3. Microbiological analysis revealed that E. coli counts was high in products prepared with Manipinta even though there was no significant variation in total viable aerobic plate counts at 30⁰C in all groundnut varieties.
4. Dzowe prepared with Chinese was found to have a very minimal amount of mould and yeast count whereas all the other samples fell above the recommended limit.
5. Coliform counts fell within recommended limit for all samples with the exception of Zinkarsie.
6. Sensory evaluation analysis showed that JL-24 was most preferred for plain roasted groundnut whereas there was no varietal difference in the Dzowe samples.
7. Manipinta was found to have the highest pH value.

3.2 Recommendations

Based on the study the following recommendations were made:

1. Studies should be conducted to establish storage period for the five varieties of groundnut so as to eliminate as much as possible chronic microbial contaminant during storage.
2. Cleanliness of drying facilities as well as personal hygiene of individuals handling the commodity should be ensured, as these could also be sources of microbial contamination.

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Aerobic plate counts

Standard method NMKL 86 (1999) of the Nordic Committee on Food Analysis.

Mould and yeast counts

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Coliform counts

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E. coli

Standard method NMKL 125 (1996) of the Nordic Committee on Food Analysis.

Salmonella species

Standard method NMKL 71 (1999) of the Nordic Committee of Food Analysis

Bacillus cereus

Standard method nmkl 67 (1997) of the Nordic C ommittee on Food Analysis.

ph was measured with ph meter.

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