

Development of Whole Cassava Based Instant Noodles

PROF. EMMANUEL O. ALUYOR

Department of Chemical Engineering
University of Benin, Benin City, Edo State
Nigeria

Email: eoaluyor@yahoo.com

ONYEKA S. OKWUNDU

Department of Chemical Engineering
University of Benin, Benin City, Edo State.
Nigeria

Corresponding Author Email: onyeka.okwundu@eng.uniben.edu

ABSTRACT

The demand for instant noodle food in Nigeria is on a progressive increase. Instant noodle food is made from wheat flour, an imported commodity. Survey of literature proved cassava to be a potential alternative. This research is aimed at investigating the effects of soybean-fortification, frying and oven drying of noodles on the nutritional qualities and consumer acceptability of cassava based instant noodle food. Freshly harvested cassava tubers were safely processed to whole cassava flour. Optimal matrices of cassava flour, soybean flour and palm olein were estimated by modeling to minimize cost and attain nutritionally balanced diet. Instant noodle food was processed from optimally-soybean-fortified cassava flour, whole cassava flour and whole wheat flour, each by frying and by oven drying. The six noodle products produced were analyzed for nutritional composition and consumer acceptability by proximate analysis and sensory analysis respectively. The proximate analysis result proved oven dried optimally fortified cassava based noodles to be the most nutritious with a standard deviation (from balanced diet) of 5.2, followed closely by oven dried whole cassava based noodles (5.5). The wheat based noodles were the least nutritious with standard deviations of 27.2 for the oven dried sample and 33.5 for the fried one. Sensory analysis resulted to overall consumer percentage ratings of 68.3% and 74.4% for fried and oven dried wheat based noodles respectively followed by the fried and oven dried optimally fortified cassava based noodles which were rated 64.4% and 66.7%, then the fried and oven dried whole cassava based noodles (61.7% and 57.2% respectively). It was concluded that oven drying is a better method of drying than frying and that soybean-fortification improves the qualities of cassava based instant noodles from the standpoints of nutritional qualities and consumer acceptance.

1 INTRODUCTION

Nigeria is one of the countries in Africa that have wide varieties of natural resources. She is richly endowed with agricultural resources. Cassava (*Manihot spp.*) being one of these resources is cultivated in virtually all states of the federation mainly for direct consumption as food, by processing into starch, flour, fufu, gari, etc. As a result, Nigeria has been the world largest producer of cassava since the year 2005 (Elemo, 2013; Elohor et al., 2014; FAOSTAT, 2013; Kolawole and Akingbala, 2008).

Despite her rich agricultural heritage, Nigeria happens to be one of the ten largest wheat importers in the world (FAOSTAT, 2013), as more Nigerian foods based on wheat flour are available now than before, both in variety and number. This, directly or indirectly contributes to the poor economic status of the country. To reduce this dependency on the foreign raw material, wheat, the Nigerian local food industry must consider local materials to substitute wheat flour as a raw material for commercial food production. Going by the usual saying, “when the desirable is not available, the available becomes desirable”, the abundant Nigerian cassava, which can be processed into flour is a potential substitute for the so desirable unavailable wheat flour.

Besides directly reviving the economy, the country needs to be medically conscious of what she imports as food, for “health” they say, “is wealth”. The globally accepted wheat flour, on which Nigerian pastas and confections are based contains gluten, a toxic protein (Samsel and Seneff, 2013; Punchng, 2013) and has great potential to elevate diabetes (John, 2009; Berkeley 2012; Elemo, 2014). The earlier Nigeria begins to explore her locally available resources, the safer for her.

Meanwhile instant noodle food, is one of the major commercial food products for which wheat flour is increasingly being imported based on the rising consumption of the product (WINA, 2014; Elemo, 2014). Instant noodle food has been made successfully from cassava flour (Akhmad et al., 2013; Sanni et al., 2004) but the process has not been developed (Elemo, 2013; Akhmad et al., 2013) let alone being commercialized. Though most researchers have used wheat-cassava composite flour, the need for cassava-based (zero wheat) noodles cannot be overstressed.

Consequently, for cassava-based noodles to gain market acceptance in a market where wheat-based noodle food already exists, several modifications must be made to improve the quality of the local cassava-based product and that is the gap this research is called on to fill.

2 MATERIALS AND METHODS

2.1 PREPARATION OF CASSAVA FLOUR

The cassava tubers were peeled on arrival at the laboratory, washed and cut to an average size of 10cm to expose the pulp to water, then soaked completely in plastic bucket of water for about 20 hours to allow for fermentation, to free the bound HCN as recommended by Akinpelu et al. (2011). The fermented tubers were manually cut into round chips of uniform sizes (about 2mm thick) using papaya shredder and oven dried at 65°C for about 24hours. The dried chips were ground and sieved to about 0.05mm over a large bowl to obtain fine cassava flour (Sanni et al., 2004).

2.2 PREPARATION OF SOYBEAN FLOUR

The soybean seeds were sorted and soaked in water for about 10hours, for fermentation. The beans were drained of water and blanched in boiling water for about 15minutes to free the seed coat. Furthermore, the beans were hulled (by rubbing in-between palms, floating and decanting the hulled seed coats), dried (at 65°C for about 7hours), ground and sieved (just as with the cassava) to obtain fine soybean flour (Sanni et al., 2004).

2.3 OPTIMAL FORTIFICATION OF CASSAVA FLOUR

The nutritional (carbohydrate, protein and fat) composition of palm olein (X_3) was sourced from the raw material sachet label, while those of cassava (X_1) and soybean (X_2) flours were

determined by proximate analysis. Linear models were formulated for optimization (minimization) of cost, K as shown below.

Results from raw materials (X_1 and X_2) proximate analysis, as well as the nutritional fact on the purchased palm olein (standard product) are tabulated on table 2.1. The cost of palm olein as well as the estimated costs of cassava and soybean flour is also included in the table. In addition, the balanced diet requirement is provided.

Table 2.1: Parameters for Linear Programming

	Carbohydrate (g/g)	Protein (g/g)	Fat (g/g)	Cost (₹/g)
Cassava flour (X_1)	0.8275	0.07	0.01	0.13
Soybean flour (X_2)	0.4915	0.3675	0.04	0.40
Palm olein	0	0	1	0.33
Dietary requirement per 240g	162.70	27.10	35.30	

Section1: For Oven Dried Instant Noodles.

$$\begin{aligned} \text{Minimize:} \quad & K = 0.13X_1 + 0.40X_2 + 0.33X_3 \\ \text{Subject to:} \quad & 0.8275X_1 + 0.4915X_2 + 0X_3 = 162.744 \\ & 0.07X_1 + 0.3675X_2 + 0X_3 = 27.1 \\ & 0.01X_1 + 0.04X_2 + X_3 = 35.3 \\ & X_1, X_2, X_3 \geq 0 \end{aligned}$$

Section 2: For Fried Instant Noodles.

$$\begin{aligned} \text{Minimize:} \quad & K = 0.13X_1 + 0.40X_2 \\ \text{Subject to:} \quad & 0.8275X_1 + 0.4915X_2 \geq 162.744 \\ & 0.07X_1 + 0.3675X_2 \geq 27.1 \\ & X_1 + X_2 = 240 \\ & X_1, X_2 \geq 0 \end{aligned}$$

The formulated models were solved by Simplex method using Microsoft Excel for a 240g of product from the determined raw materials nutritional compositions with the aim of minimizing raw materials cost and meeting the daily dietary requirement of <http://www.mydailyintake.net> and <http://www.nutrition.com>, as treated by Gupta and Hira (2011). The optimization was in two sections; one for hot air (oven) dried noodles in which case all the three nutritional parameters

were considered and the other for oil fried noodles in which case fat content is fixed by the frying condition (2minutes-deep oil frying at about150°C) as documented on Wikipedia (2014a), thus the fat content was not considered.

2.4 PROCESSING OF INSTANT NOODLES

Calculated/optimal amounts (205.38g and 34.62g) of cassava flour and soybean flour were weighed out and placed in a bowl, then mixed for about 5minutes. The whole step was repeated with 172.31g of cassava and 40.92g soybean flour but this second time, calculated amount (31.94g) of palm olein was added before mixing, then the two resulting bowls of mixed flour and mixed flour plus oil were labeled 'A₁' and 'A₂' respectively. Also two 240g of whole cassava flour were weighed out and placed in separate bowls labeled 'B₁' and 'B₂'. In the same manner, two 240g of whole wheat flour were weighed out and placed in separate bowls labeled 'C₁' and 'C₂' to serve as control. Same amount of palm olein as used for A₂ was added to samples B₂ and C₂. Aqueous salt solution (5 g/L) was prepared in a bowl up to a litre.

Furthermore the prepared solution was used to form dough from each of A₁, A₂, B₁, B₂, C₁ and C₂, by adding suitable amount (about 15cl to taste) of the solution in a new bowl then adding gradually, A₁, A₂, B₁, B₂, C₁ or C₂, as the case could be and mixing for about 20minutes, making up with water where necessary to get thick dough. From the dough forming step to the drying step, the production was carried out one after the other, for the six batches to avoid resting the dough for a long time as that could lead to a softer noodle than desired (Akhmad et al., 2013). Each of the samples was kneaded by repeated flattening and folding with hands for about 2minutes. The dough from C₁ and C₂ were rested for about 35minutes to mature, before they were kneaded.

Afterwards, the method of shaping pasta, which involves extrusion through metal die as documented by Widjaya (2010) was used but with a local plastic extruder and on a laboratory (small) scale, to obtain long thin strips of about 2.5mm diameter. That was done by charging the dough into the extruder and applying pressure. The strips were cut (20cm long, for easy handling) and steamed in basket over boiling water at 100°C for 3minutes before drying. Samples A₁, B₁ and C₁ were dried by deep oil frying at 150°C (using the electric stove with thermostat regulator) for about 2minutes, while A₂, B₂ and C₂ were by hot air (at about 80°C for about an hour) in oven.

2.5 MODIFICATIONS ON THE METHOD OF PRODUCTION

Cassava starch was prepared with cassava flour to serve the binding function of gluten in samples A₁, A₂, B₁ and B₂, as the earlier used dough formation process led to non pliable, non cohesive dough, which on extrusion undesirably cut into bits. First, 60g of cassava flour was weighed out and cooked with equal volume of water for about 4 minutes and stirring at intervals till sticky brownish slurry was obtained. The slurry was then mixed thoroughly with the rest flour (whole cassava or cassava and soybean), to obtain a dough characteristic of wheat.

Secondly, the method of shaping pasta, that involves extrusion through metal die as documented by Widjaya (2010), could not be used to shape the dough from wheat flour. Therefore the wheat flour based dough was slit to about 2mm diameter strands using kitchen knife.

2.6 TESTING OF THE NOODLE SAMPLES

Sensory evaluation of the six noodle samples was carried out, adopting the method of Sanni et al. (2004) and Akhmad et al. (2013). A panel of 10 student judges who were regular noodle eaters (by interview) was set up for sensory evaluation of the noodles. The noodle samples: A₁, A₂, B₁, B₂, C₁ and C₂ were one after the other cooked and served to the panellists while the cooking pot was washed at intervals. sachets of Chile seasoning powder from Indomie packs were used to cook the noodle samples. The judges were each provided with a questionnaire and asked to rate each of the samples as they were served, for taste, aroma, texture (chewiness) and appearance, using a 5point hedonic scale; where 1 represents extreme dislike and 5, extreme like.

Also proximate analysis was carried out on each of the samples by the method of Pearson (1976), Udo and Ogunwele (1986), to determine the nutritional compositions: moisture, ash, fat (ether extract), crude protein, crude fibre and NFE (carbohydrate), after sample preparation by pounding and sieving. Only the parameters: fat, protein and carbohydrate were primarily considered for nutritional fortification due to the ease in manipulating them.

3 RESULTS AND DISCUSSION

3.1 PROXIMATE ANALYSIS OF RAW MATERIAL SAMPLES X₁ AND X₂

Table 3.1: Proximate Analysis Result for Raw Material Samples

SAMPLES	NUTRITIONAL PARAMETERS					
	Moisture	Ash	Fat	Fibre	Protein	Carbohydrate
X ₁ (%)	8.75	0.40	1.00	0.10	7.00	82.75
X ₂ (%)	7.60	2.30	4.00	0.20	36.75	49.15

3.2 RESULT OF LINEAR PROGRAMMING

The optimal quantities of palm olein, soybean flour and cassava flour obtained by solving the linear program models were respectively: 31.94g, 40.92g and 172.31g, for the hot air dried noodles and 34.62g of soybean flour with 205.38g of cassava flour, for the fried noodles. The optimal (minimal) costs are ₦49.31 for the hot air dried noodle major raw materials and ₦40.55 for the fried noodles.

3.3 OBSERVATIONS FROM THE METHOD OF PRODUCTION

The production of noodles as described in section 3.2.1.4 was not successful. Formation of cassava dough for samples A₁, A₂, B₁ and B₂, which do not involve wheat or gluten, resulted to a non pliable, non cohesive, thick mixture which on extrusion undesirably cut into bits. This non binding nature of cassava only features at relatively low temperatures. Heating cassava flour-water mixture to about 100°C for few minutes yields a jelly binding starch which when mixed with normal cassava flour yields better dough. No wonder, Akhmad et al. (2013) insist that when compared to other starches, cassava starch contains more amylopectin (87%) than amylose. And amylopectin has a higher viscosity than amylose, resulting in stickiness and a higher viscosity in cassava starch.

On the other hand the dough from wheat flour, the known perfect dough former could not be shaped by extrusion. Figure 3.3 shows the undesirable outcome, whereby the formed noodle strings leaving the can remain at the aperture and get amassed. This undesirable result could be as a result of the gluten content of wheat.

3.4 RESULT OF PROXIMATE ANALYSIS OF NOODLE SAMPLES

The result of proximate analysis on the six noodle samples for the nutritional parameters in the Faculty of Agriculture Laboratory Research and Teaching Unit, University of Benin, Benin City is reported in table 3.2, alongside the recommended daily intake (RDI) values (for the nutritional variables of interest) and the standard deviation of each of the samples from the RDI.

Table 3.2: Result of Proximate Analysis of the Noodle Samples

SAMPLES	NUTRITIONAL PARAMETERS						S.Deviation
	Moisture	Ash	Fat	Fibre	Protein	Carb.	σ
A ₁ (%)	5.10	1.00	33.10	0.10	12.25	48.45	26.9
A ₂ (%)	5.00	1.00	17.30	0.20	12.70	63.80	5.2
B ₁ (%)	5.20	1.00	30.20	0.10	8.75	54.75	20.6
B ₂ (%)	5.10	0.90	18.10	0.20	7.00	68.7	5.5
C ₁ (%)	5.30	1.00	30.20	0.10	22.75	40.65	33.5
C ₂ (%)	5.10	1.00	21.10	0.20	26.25	46.35	27.2
RDI (%)			14.8		11.4	68.2	0

Obviously, from the proximate analysis result that sample A₂ (oven dried optimally fortified cassava based noodle food) is the most nutritious with a standard deviation (σ) of just 5.2 from the recommended daily intake (RDI). This is as a result of the optimization of the 3 considered major parameters in A₂. While for A₁ (the fried counterpart), an overall deviation of 26.9 was obtained as the fat content was not optimally fixed but depends on the frying condition and going by the method of analysis for carbohydrate, it is affected negatively by positive increase in other parameters. As a result only the protein content of A₁ is close to optimal since the deviation of the fat content deviates the carbohydrate content as well; thus the high overall deviation. The minor deviation of A₂ from the RDI could be linked to experimental errors.

As expected, the addition of soybean flour (as a nutritional fortifier) successfully raised the protein content of samples B₁ and B₂ from 8.75 and 7% to 12.25 (A₁) and 12.7% (A₂), all respectively. This observation is expected and that is why Ihekoronye and Ngoddy (1985) recommend nutritional fortification of cassava flour for use in food production.

Contrary to the statement of SANA (2014), that soybean flour improves taste and texture of many common foods and often reduces the fat absorbed in fried foods, the addition of soybean

flour to cassava as with sample A₁, on frying absorbed more fat (33.1%) than the fried whole cassava based noodles B₁ (30.2%). The reason for this discordance may lie on the frying condition. Or this may be one of the excluded cases, as the statement covers ‘many’ common foods.

Generally, fried noodle samples (those with subscript 1) all showed higher fat content than their oven dried counterparts (those with subscript 2). This can be explained considering the fact that frying in deep oil exposes food to large amount of oil, while drying in the oven retains only the fat already present in the food before drying without further net increase. This result would be very relevant in regulating dietary fat; since it follows that dietary fat can be regulated by drying food samples in oven rather than frying in oil.

On the other hand the protein content of wheat based noodles C₁ and C₂ were unexpectedly higher than expected; the reason for this unexpected high protein content could not be boldly proffered, but may lie on the resting time which might have led to much gluten development. This is strange because Akhmad et al. (2013) document that wheat flour contains 8-13% protein and Ejembi et al. (2014) suggest that a typical wheat based noodle should contain about 12% protein.

Altogether, if one is to consider the nutritional values of the samples, the order of choice should be, starting from the most desirable: A₂, B₂, B₁, A₁, C₂, and then C₁. It may seem strange that B₂ and B₁ are preferable to the ‘so optimized’ A₁? The reason remains centered on the fact that A₁ has very high fat content which offsets the carbohydrate content.

3.5 SENSORY EVALUATION OF NOODLE SAMPLE

The result collated from questionnaires, filled by panellists on analyzing the organoleptic qualities of the cooked and served noodle samples is presented in table 3.3 with overall response, all on percentage rating

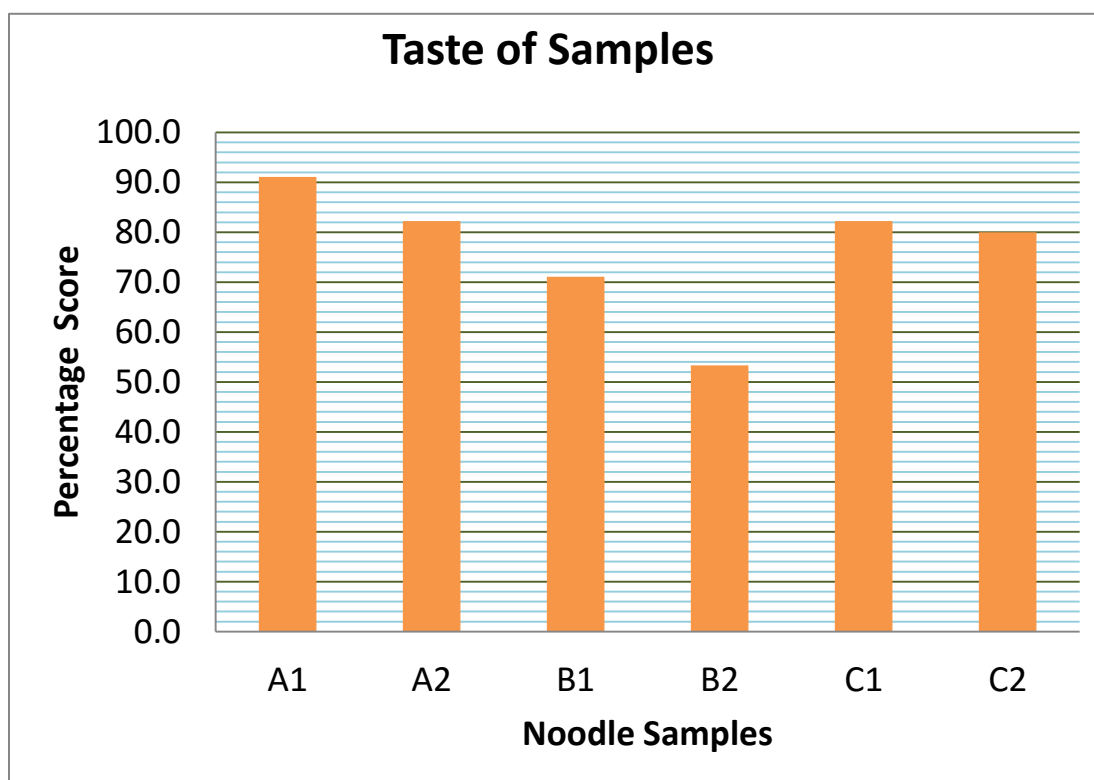
Table 3.3: Collated Sensory Evaluation Result from Questionnaires

SAMPLES	SENSORY EVALUATION RESULT				Overall (%)
	TASTE (%)	AROMA (%)	TEXTURE (%)	APPEARANCE (%)	
A1	91.1	53.3	53.3	60.0	64.4
A2	82.2	55.6	57.8	71.1	66.7
B1	71.1	46.7	62.2	66.7	61.7
B2	53.3	48.9	68.9	57.8	57.2
C1	82.2	71.1	73.3	46.7	68.3
C2	80.0	75.6	86.7	55.6	74.4

Observing from table 3.3, the ratings for aroma, texture and appearance for the various samples are all poor (far from 100%) while those for taste are appreciably high (close to 100%). This could be as a result of the raw materials and the crude method of production employed. Okolie (2014) and Ejembi et al. (2014) report that Indomie (a standard noodle brand) is made with premix C (for improved texture) and tartrazine (for desirable colour). But this research on a long run is goaled towards developing simpler, cheaper and safer alternative for the noodle industry. Therefore the use of premix C, whose composition remains undisclosed and tartrazine, which is toxic (Ejembi et al., 2014) were avoided. The reason for the appreciably high taste of samples may be due to the fact that sachets of Chile seasoning powder from Indomie packs were used to cook the noodle samples.

Obviously from the illustration of figure 3.1, frying improves the taste of noodles. All fried noodle samples (those with subscript 1) have more desirable taste than their oven dried counterparts (those with subscript 2).

Figure 3.1: Variation in Taste for the Various Noodle Samples



It also follows from figure 4.1 that the addition of soybean flour improves the taste of cassava based noodles and places it on higher ground for competition with the wheat based counterpart. This is because soybean fortified cassava based noodles (A_1 and A_2) are distinctly higher than whole cassava based noodles (B_1 and B_2) in taste rating.

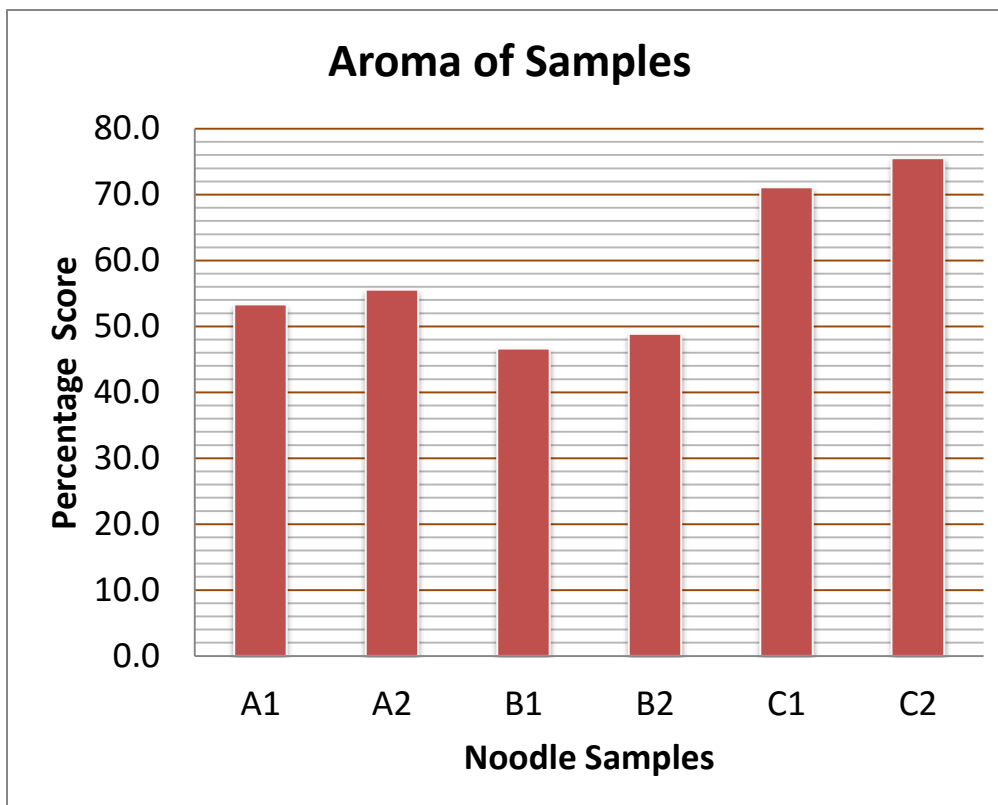


Figure 3.2: Variation in Aroma for the Various Noodle Samples

Figure 3.2 depicts that cassava depletes the aroma of instant noodle food. The wheat based noodles, C₁ and C₂ have distinctly high aroma, followed by A₁ and A₂ then the whole cassava based B₁ and B₂. This is normal because the aroma of cassava irritates. The addition of flavour may prove remedial.

Also figure 3.2 shows that oven drying yields more desirable products (with respect to aroma) than frying though the gap is not that distinct.

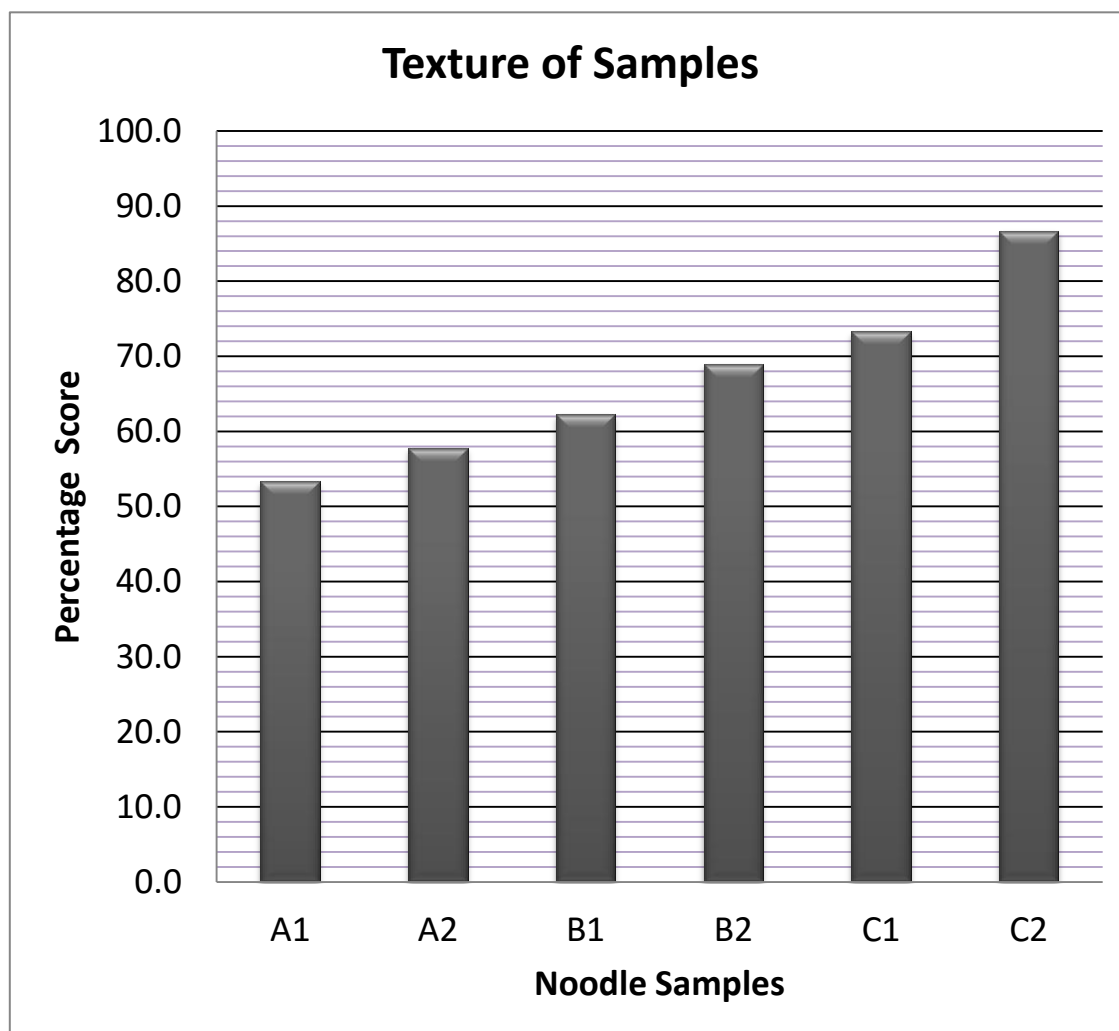


Figure 3.3: Variation in Texture for the Various Noodle Samples

From figure 3.3, oven drying favours the texture of noodles for all compositions. This is not surprising as frying imparts thermal shock on cool shaped noodle strands which results in the stiff texture even after cooking; one can imagine the possible temperature difference (from about 30°C the cool shaped strands get suddenly heated in oil at about 150°C, in this case), all in the name of drying by frying. Oven drying is more thermal shock considerate, as it is achieved at lower temperature (in this case at 80°C).

Wheat based noodle food had the most desirable noodle texture, while fortification of cassava led to a reduction in noodle texture. This depicts why Ihekoronye and Ngoddy (1985) document that the fortified cassava based noodles should not be expected to have same characteristics with the usual ones made of whole wheat or whole cassava flour. Consequently, this case falls into the exceptions excluded by SANA (2014) in the statement that soybean flour improves the taste and texture of many common foods. This seems a contradiction but it is rather an exception; as the statement covers 'many' common foods.

Considering the appearance of various cooked and served noodle samples, figure 4.4 shows that fried whole cassava based noodle food is better than the oven dried one, while for the fortified cassava and whole wheat based noodles, oven drying gave better appearance than the corresponding fried samples.

Furthermore the reported poor appearance of wheat based noodles (C₁ and

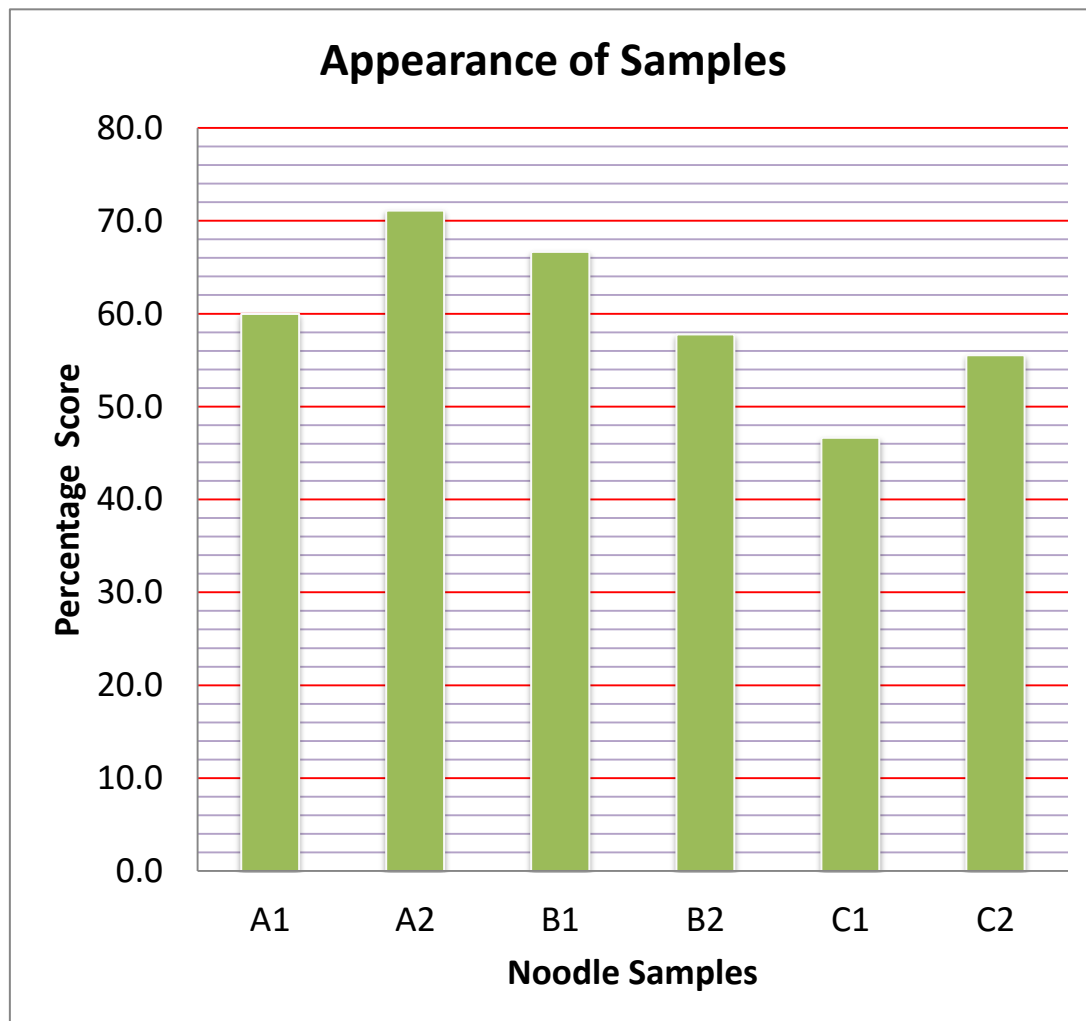


Figure 4.4: Variation in Appearance for the Various Noodle Samples

C₂) has reasons not far from the shaping method devised as alternative to the impracticable extrusion of wheat dough. The sample was shaped by cutting manually with kitchen knife. As a result, it appeared bigger in size and non uniform.

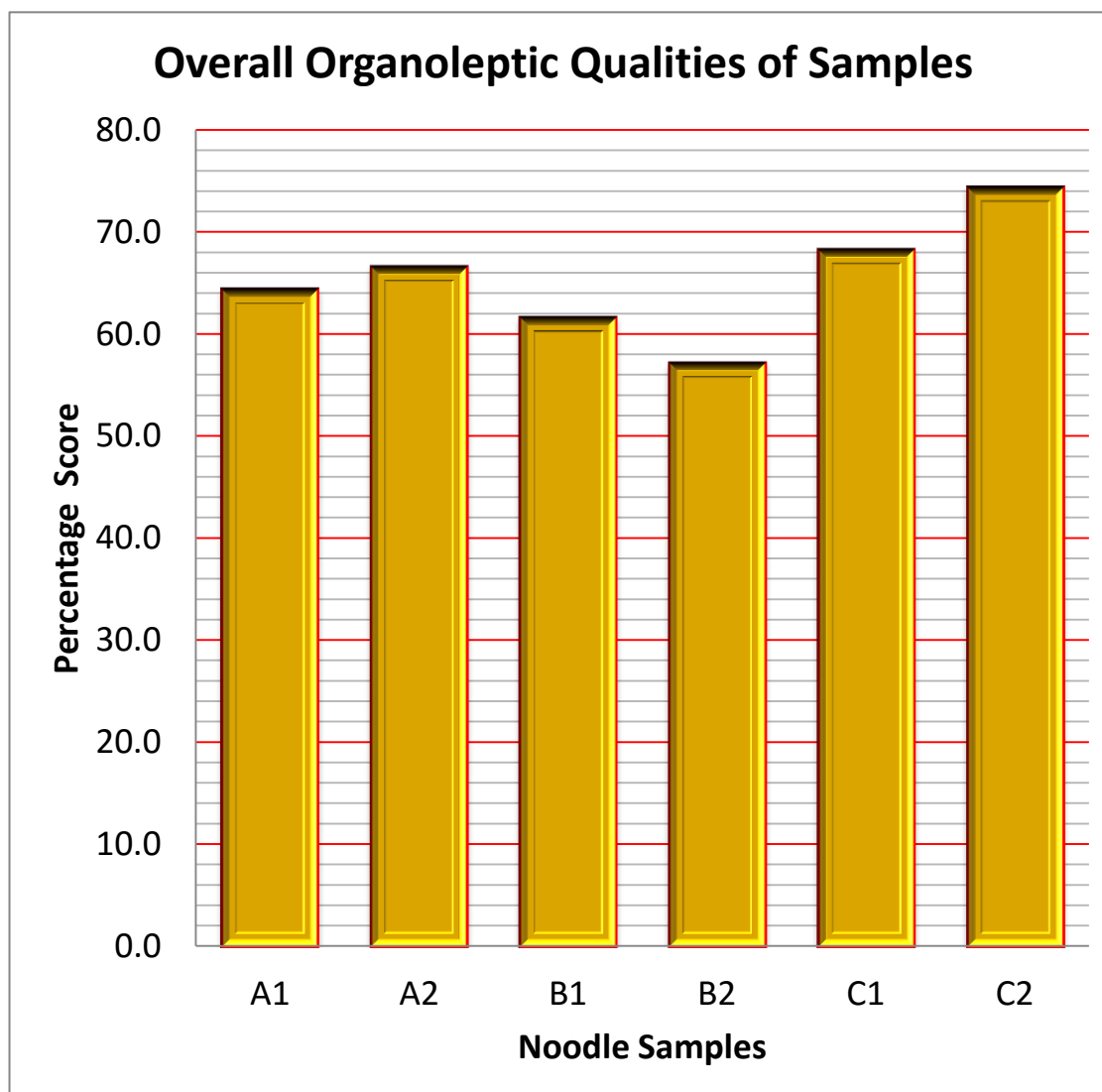


Figure 4.5: Cumulative Variation in the Organoleptic Qualities of Various Noodle Samples.

Altogether, the overall (cumulative) variation in: taste, aroma, texture and appearance for all the noodle samples on a percentage rating is illustrated in figure 4.5. The wheat based noodle samples, C₁ and C₂ are outstanding with overall percentage ratings of 68.3% and 74.4% respectively while the optimized cassava based noodles follow in competition, with A₁ rating 64.4% and A₂ rating 66.7%, then the least rated cassava based noodle samples which have 61.7% for B₁ and 57.2% for B₂.

Obviously, usual noodle eaters (the panellists) would rate normal, noodles of similar organoleptic qualities to their usual fried wheat based instant noodle food like Indomie, which experimentally was represented with C₁ as control sample. If that is the case, then the preference of C₂ to C₁ as figure 4.5 illustrates, proves that oven dried wheat based instant noodle food would be preferable to the fried one which virtually all noodle companies in Nigeria are producing. This is because figure 4.5 depicts C₂ to be distinctly higher than C₁ in overall organoleptic quality rating.

Similarly, the oven dried fortified cassava based noodle food was preferred to the fried one while on the contrary, the fried whole cassava based sample was more desirable than the oven dried one. This outcome (though not reasonably distinct enough for generalization or conclusion) would be very helpful for further development of cassava based noodle food, as the choice of drying method could be easily made.

Finally, Sanni et al. (2004), while analyzing the sensory or organoleptic qualities of their instant cassava-wheat-soybean noodles, report that there were significant differences in the sensory attributes; the acceptability of the product dropped progressively as larger quantities of cassava were added. Their report proves the poor rating of B₁ and B₂ relative to other samples to be with one accord.

4 CONCLUSIONS AND RECOMMENDATIONS

Soybean-fortified cassava based instant noodle food has greater consumer acceptability than whole cassava based instant noodle food dried by the same method.

Oven drying is a better drying method than frying for all noodle samples from the standpoint of nutritional value. Dietary fat can be regulated by oven-drying food samples rather than frying in oil.

Based on nutritional and organoleptic qualities, for the wheat based instant noodle food, oven drying is better than frying. Since virtually all noodle companies in Nigeria employ the frying method of drying noodles, it is recommendable that oven drying be considered for industrial application.

Cassava based instant noodles can be shaped by the method of extrusion while wheat based instant noodles cannot. It is recommendable that comparative studies be carried out to determine a better means of shaping cassava based noodles (by slitting, extruding or even any other means).

Other protein-rich foods such as groundnut should be used for optimal cassava fortification. Other food nutrients such as fibre, vitamins and minerals should also be considered for optimization (may be by adding relevant supplements).

REFERENCES

- Akhmad A.Z., Cinantya D. and Adeline, (2013) "Development of Wet Noodles Based on Cassava Flour", *Journal of Engineering Technology and Science*, 45(1), p.97-111.
- Akinpelu A.O.L., Amangbo E.F., Olojede A.O. and Oyekale A.S., (2011), "Health Implications of Cassava Production and Consumption", *Journal of Agriculture and Social Research*, 11(1), p.4-7.
- Berkeley W., (2012), "Should You Worry about Wheat?" <http://www.berkeleywellness.com/healthy-eating/nutrition/article/should-you-worry-about-wheat> accessed on 12th August, 2014.
- Ejembi D., Sanni M., Emmanuel F.T. and Abbah O.C., (2014), "Evaluation of the Biochemical Composition and Proximate Analysis of Indomie Noodle", *International Journal of Medical and Applied Sciences*, 3(1), p.10-14.
- Elemo G.N., (2013), "The Prospects and Challenges of Cassava Bread and Confectioneries in Nigeria".

- Elemo G.N., updated on 25th April, (2014) “The prospects and challenges of cassava bread and confectioneries in Nigeria” <http://www.manufacturingtoday.com.ng/2013/04/25/the-prospects-and-challenges-of-cassava-bread-and-confectioneries-in-nigeria/> accessed on 12th August, 2014.
- Elohor U.O., Olasunkanmi G.S. and Kehinde T.A., (2014), “Studies on the Production and Utilization of Dried Cassava Chips as Human Food”.
- FAOSTAT (2013), “FAO Statistical Yearbook”, World Food and Agriculture, Food and Agriculture Organization of the United Nations, Rome, 2013, Map 51, p.157.
- Gupta K.P. and Hira D.S., (2011), “Operations Research”, 5th Edition, S. Chand and Co. LTD, Ram Nagar, New Delhi.
- Ihekoronye A.I. and Ngoddy P.O., (1985), Chapter 12: Organoleptic Qualities Of Food, in “Integrated Food Science and Technology for the Tropics”, Macmillan Education LTD, London.
- John B. (2009), “Can Wheat Cause Diabetes?” <http://www.theepochtimes.com/n2/health/can-wheat-cause-diabetes-23026.html> accessed on 12th August, 2014.
- Kolawole F.O. and Akingbala J.O., (2008), Chapter 10: Improved Nutrition and National Development through the Utilization of Cassava in Baked Foods, in “Using Food Science and Technology to Improve Nutrition and Promote National Development”, Robertson, G.L. and Lupien, J.R., (Eds), p.1-10.
- Okolie D.U., (2014), “Report of One Year Industrial Training Undertaken at De-United Food Industries Limited Ota”, Delta State Polytechnic, Ogwashi-Uku, Delta State.
- Pearson (1976), “Proximate Analysis of Food Materials”. Journal of Food Chemistry, 12(67), p.8084.
- Punchng (2013), <http://www.punchng.com/feature/healthy-eating/how-wheat-destroys-health/> accessed on 8th August, 2014.
- Samsel A. and Seneff S., (2013), “Glyphosate, Pathways To Modern Diseases II: Celiac Sprue And Gluten Intolerance”, Interdiscip Toxicol. 6(4), p.159–184.
- SANA: Soyfoods Association of North America, (2014) “Soy Fact Sheets”, <http://www.soyfoods.org/soy-products/soy-fact-sheets> accessed on 29th August, 2014.
- Sanni L.O., Bamgbose C.A. and Sanni S.A., (2004), “Production of Instant cassava Noodles”, Journal of food Technology, 2(2) p.83-89.
- Udo E. J. and Ogunwele J. A. (1986), “Laboratory Manual for the Analysis of Soil, Plants and Water Samples”, 3rd edition, Department of Crop Production, University of Ilorin, Kwara State, p.131-152.
- Widjaya C., (2010), “The Impact of Ingredient Formulation and Processing Parameters on Colour and Texture of Instant Noodles”.
- Wikipedia, updated on 15th May, (2014a), http://en.wikipedia.org/wiki/Instant_noodle accessed 16th May, 2014.
- WINA: World Instant Noodles Association (2014), <http://instantnoodles.org/noodles/expanding-market.html>