The suitability of water yam (D*ioscorea alata*) for couscous production

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Abstract

Consumer utilization of water yam (*Discorea alata*) could be enhanced if this specie of yam is processed into a more stable, acceptable and convenient food form. A study on the suitability of *D. alata* in the production of couscous was conducted. Yam couscous was prepared from fifteen varieties of *D. alata.* The products were prepared using the blanched-grated-tuber. Couscous from TDa 99/00528, TDa 291 and TDa 98/001168, TDa 99/00199 and TDa 99/00214 were judged as the most preferred based on general sensory qualities and peak viscosity. However, two variety, TDa 297 and TDa 98/01166 were used for storage studies. The moisture content, pH, microbial load, and sensorial qualities of the yam couscous were determined during a 24 week storage studies. The moisture content, pH and the microbiological load of water yam couscous conforms to food standards for couscous. Although semolina couscous was generally preferred to yam couscous, yam couscous had similar sensory ratings as semolina couscous and was acceptable to the consumers over the storage period.It is therefore possible to produce couscous from *Discorea alata* which will be safe for human consumption and keep for not less than 24 weeks in a cool dry place.

Keywords: Water yam, couscous, sensory evaluation, microbial load, semolina.

Introduction

D. alata, commonly referred to as 'winged yam', 'water yam' or 'greater yam' has high moisture content and high nutritional content (crude protein - 7.4%; starch - 75-84 %; and Vitamin C - 13.0 - 24.7 mg/100 g (Osagie, 1992). The tubers are bulky and highly susceptible to spoilage hence processing them into more stable product will increase shelf life, availability, enhance its usage and provide variety.

The main processed forms in which yam tubers are consumed or preserved is flour (Akoroda, 1995; Iwuoha, 2003) and in Benin product like *wasawasa* or couscous have been exploited. These products are normally made from the White yam (*Dioscorea rotundata Poir*) whilst neglecting other yams species especially Water yam (*Dioscorea alata). D. alata* has been the least choice compared to white and yellow yams due to its generally loose watery texture (Opara, 1999). Consumer utilization of water yam could be enhanced if this species of yam can be processed into a more stable, acceptable and convenient product.

Couscous is a kind of pasta traditionally made from gritty wheat flour (*Triticum turgidum*) (Wright, 2006) rolled into tiny granules of uniform size, with the aid of water and smooth flour. The granules are precooked, dried in the sun, and stored. (www.en.wikipedia.org). Couscous is prepared by steaming, and served with meat or vegetable stew on it. It can also be eaten alone, flavoured or plain, warm or cold, as a dessert or a side dish (Aboubacar and Hamaker, 1999).

The study therefore seeks to investigate suitability of water yam in the production of couscous and the consumer acceptability of the product.

Materials and methods

Raw materials

Fifteen *D. alata* varieties, *Matches, Red water yam,* TDa 99/00208, TDa 98/01166, TDa 99/00528, TDa 297, TDa 291, TDa 98/01176, TDa 98/ 001168, TDa 99/00240, TDa 99/000480, TDa 99/00199, TDa 98/01174, TDa 99/00214

and TDa 99/00049, were obtained from the Savanna Agriculture Research Institute (SARI) Nyankpala; and Crop Research Institute (CRI) Fumesua, Ghana.

Several studies, not reported in this paper, were carried out on the 15 *D. alata* varieties to select varieties for further studies. Based on peak viscosity and general sensory performance by untrained panellists, TDa 98/01176, TDa 98/001168, TDa 297, TDa 99/00528 and TDa 99/0048 were the best varieties for yam couscous. The varieties selected were based on the overall acceptability. TDa 297 (the overall best sample) and TDa 98/01166, which had no significant difference with the second best samples, TDa 99/00528 and TDa 98/01176 were used for storage studies.

Methods

Couscous was prepared by the blanched-grated-tuber (BGT) method (Figure 1). Storage studies were conducted every 8 weeks, for 24 weeks on samples stored in a cool dry place. This included sensory evaluation by trained panellists, microbiological evaluations, moisture (AOAC, 1990) and pH (AOAC, 2000) of the couscous samples were measured to evaluate the quality of the product over the 24 week period.

All plating for the microbiological evaluations were done by the pour plate method. Aerobic Plate count, yeast, mould and coliform counts were carried out. Confirmatory tests for coliforms and *E. coli* were also carried out.

Sensory evaluation was done by 15 trained panellists from Food Research Institute, Accra, as well as 10 couscous consumers at Paloma Restaurant, Accra, who were made to assess one of the selected yam couscous samples for the storage life studies using the semolina couscous as standard. This group of panellists used a line scale (10cm) of 0 (Dislike very much) to 10 (like very much) to assess the product. Processed couscous were moistened with water and steamed for thirty minutes prior to sensory evaluation. Quality attributes such as colour, texture (hardness), flavour (taste and smell) and overall acceptability were assessed. The assessment of the overall acceptability was done with vegetable stew.

Analysis of variance (ANOVA), were conducted using Statgraphics statistical package (Centurion edition). Significant differences were determined at $p < 0.05$. Microsoft Excel was used in the graphical representation.

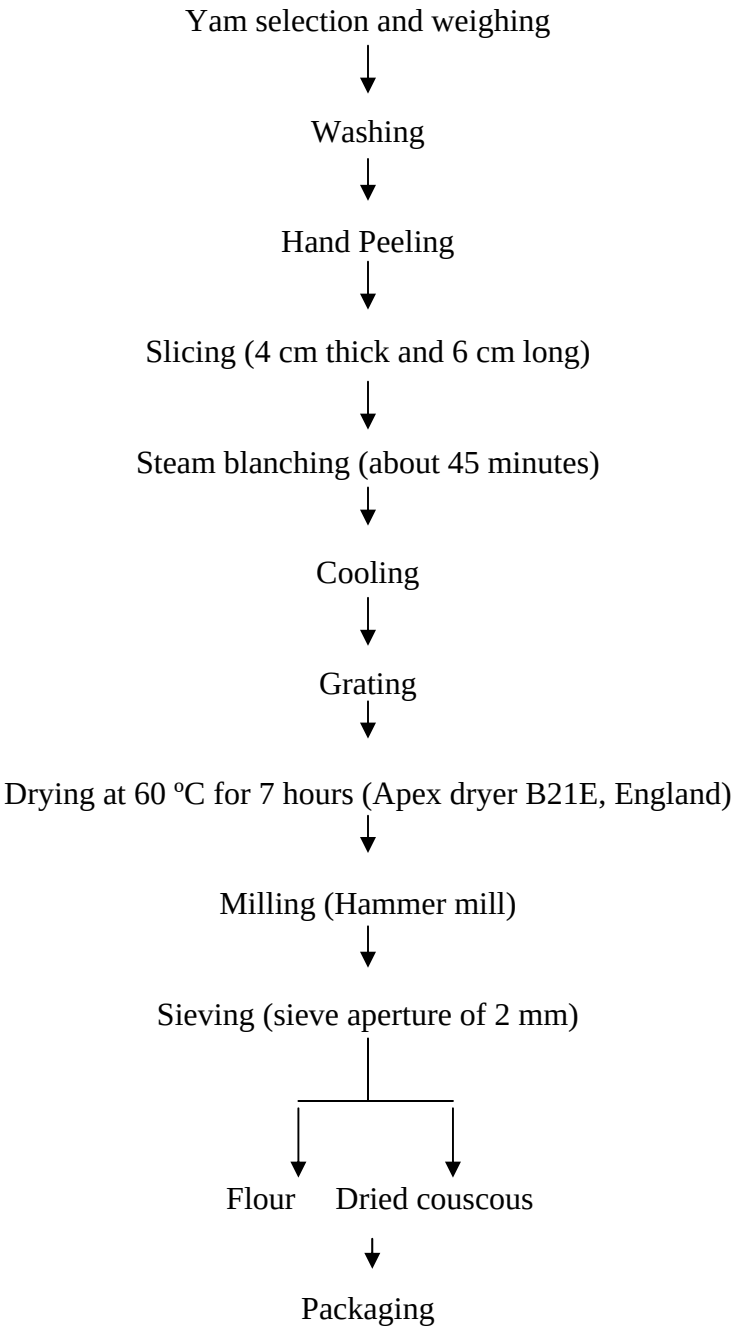

Figure 1. Flow diagram for *dried couscous* processed by the blanched-grated-tuber method

Results and discussion

Effect of moisture on the microbial growth over storage time

There was a gradual increase in the moisture content of the yam couscous samples over storage time and the variability in the moisture content of the samples were also significant ($p < 0.05$) over the storage time. The moisture content of TDa 98/01166 couscous was 8.1 % when it was freshly prepared. By the 24th week of storage, the moisture had increased to 10 %. The moisture content of TDa 297 couscous also increased from 6.6 % on the first day of preparation to 9 % by the 24th week of storage. The gradual increase of moisture in the water yam couscous samples may be due to the hydroscopic nature of the inherent starch present. Despite the gradual increase in moisture content of the yam couscous samples over storage time, the values recorded were below the 13.5 % moisture limit specified by Codex standard (Codex, Stan 202-1995). The low moisture content recorded is an indication of the shelf life stability of the product.

Effect of pH on the Microbial Growth over Storage Time

The variability of the pH of the samples and its change over the storage period were statistically significant ($p < 0.05$). There was a slight decrease in pH of TDa 98/01166 couscous sample from 5.58 on the first day of preparation to 5.32 by the 16th week, which was followed by a slight increase in pH by the 24th week to 5.4. A similar trend was followed by TDa 297 couscous, which had a pH of 5.54 on the first day of preparation, reduced to a pH of 5 after 16 weeks of storage and slightly increased to a pH of 5.1 after 24 weeks of storage. The decrease in pH could have been as a result of fermentation (Adams and Moss, 1995). However, the subsequent increase in pH could be due to the protein mass of the microbes over time. The normal pH range for bacteria growth has been reported to be between 6 and 8 (Adams and Moss, 1995). The pH ranges could have suppressed bacteria growth and could have accounted for the relatively lower Aerobic Plate Count especially in the TDa 297.

Aerobic Plate Count

TDa 98/01166 couscous recorded higher Aerobic Plate Count than TDa 297 couscous. The difference in the Aerobic Plate Count of the sample was significant ($p < 0.05$). TDa 98/01166 had an increase in the Aerobic Plate Count up to the 16th week and then decline sharply (Table 1). The increases recorded with the first 16 weeks could be that, there were enough nutrients for the growth of the bacteria. TDa 297 also observed an increase in the Aerobic Plate Count within the first eight weeks and then a subsequent decline. The variations that occurred over the storage period were also significant ($p > 0.05$). On the first day of preparation, the Aerobic Plate Count of TDa 98/01166 averaged 5.1 x 10^3 CFU/g whilst TDa 297 recorded 570 CFU/g. These variations could have been due to differences in levels of exposure of the samples during processing. The bacteria present at this time could be thermophilic organisms since the couscous samples have been dried at 60 ^oC for 7 hours. At this temperature all the mesophilic and possibly the psychrotrophic organisms which are mostly the food spoilage organisms would have been destroyed (Adams and Moss, 1995). The values recorded for Aerobic Plate Count over the 24 week storage period are all within the Ghana Standards Board acceptable limit of 1 x 10^6 for couscous (Ghana Standards, GS 730/2003).

Table 1. Mean Aerobic Plate Count (APC) and Yeast and Mould Count (YMC) of dry water yam couscous samples over the 24 weeks storage period

Sample	Period							
	Week 0		Week 8		Week 16		Week 24	
	APC	YMC	APC	YMC	APC	YMC	APC	YMC
TDa 98/01166	5.1 x10^3 ±1.4x10^2	0^a	2.7 x 10^4 ± 3.2x10^2	20^b	1.3 x 10^5 ± 2.8 x10^3	0^a	5.0 x 10^3 ±1.4x10^2	0^a
TDa 297	5.7 x 10^2 ± 1 x 10^1	0^a	5.2 x 10^3 ± 1.4 10^2	10^b	7 .0x 10^2 ± 0.0	0^a	2.0 x 10^2 ± 0.0	0^a

Values statistically different at ($p < 0.05$) shares different letters

Yeast and Mould Count

The yeast and mould growth of the samples were however not significant ($p > 0.05$), even though there were significant differences ($p < 0.05$) in their counts over the storage period. There was no mould and yeast growth in the couscous sample on the first day of preparation (week 0), 16th week and 24th week of storage. Oven drying of the yam couscous samples at 60 °C for 7 hours could have destroyed all the vegetative cells and spores of the yeast and mould that would have been present. According to Adams and Moss (1995), the vegetative cells and spores of yeast and mould are killed below 100 °C in the baking of bread. Yeast and mould growth was observed on the eighth week of storage, which were 10CFU/g and 20CFU/g for TDa 98/01166 and TDa 297 respectively (Table 1). This growth observed may be due to contamination of the samples at the time of analysis. The acceptable limits for yeast and mould levels in couscous are 500 CFU/g according to the US durum couscous specifications (Couscous specifications, 2007) and 1×10^4 CFU/g according to Ghana Standards Board specifications for couscous (Ghana Standards, GS 730/2003).

Coliforms and E. coli count

There were no Coliforms and *E. coli* growth over the storage period. The Coliforms and *E. coli* which may be present would have been killed during the oven drying of the yam couscous. From the public health stand point, the couscous samples could be recognized as safe due to the absence of Coliforms and *E. coli* (Adams and Moss, 1995).

Sensory Evaluation by Trained Panellists

Colour (whiteness of colour). There was a gradual decrease in the whiteness score of the storage period. TDa 297 couscous scored 3.71 on first assessment day. By the 24th week of storage, the whiteness score of the panellists have been reduced to 2.4. TDa 98/01166 which was the darker of the two yam couscous also scored whiteness values ranging from 0.97 to 0.93 on the first day and after 24 weeks of storage respectively. The standard couscous which was actually yellow scored an average of 0.83 for whiteness. The relatively low values of whiteness for the yam couscous recorded may be due to the amount of polyphenols that were present prior to processing (Akissoe *et al.*, 2003) and also the ferrous iron present in the tuber oxidizing to ferric iron when the yam tubers are cooked especially in water or with steam (Mornar-Perl and Friedman, 1990). The decrease in the whiteness of the yam couscous as assessed by the panellists was an indication of the darkening of the product over the storage time. The yellow colour of the semolina couscous was relatively stable during the storage period.

Appearance. Two parameters were assessed under appearance: the presence of black specks and the uniformity of the couscous grains. Very minimal black specks were recorded. However, TDa 98/01166 had the most of black specks and recorded the highest value of 1.5 on the 16th week of storage and the lowest value of 0.8 on the 8th week of storage. TDa 297 recorded black speck scores in the range of 0.9 to 0.95 while semolina couscous recorded the lowest black specks values which ranged between 0.2 and 0.24.

The variation in the uniformity of the samples over the storage period was significant ($p < 0.05$) even though yam couscous under the shelf life studies were processed using the same processing procedure. Average values of 9.44, 8.06 and 7.08 were scored for semolina, TDa 98/0166 and TDa respectively. The semolina couscous grains were the most uniform.

Flavour. The variability of the flavour acceptability of the couscous samples was not significant ($p > 0.05$). TDa 297 scored the highest flavour value of 7.9 followed by semolina couscous with a value of 7.57 whilst TDa 98/01166 recorded the lowest value of 7.1 on the first day of preparation. There were slight differences in the flavour of the samples on the 8th and 16th weeks of storage. However, there was a drastic reduction in the flavour of the samples after 24th weeks of storage. Semolina couscous, TDa 98/0116 couscous and TDa 297 couscous scored 5.08, 5.55 and 5.26 respectively. The reduction in the flavour score may be attributed to off flavour development in the samples due to absorption of unpleasant flavour components during the storage period (Perera, 2005). It could also be due to breakdown of flavour components (Basha and Young, 1996; Wilkes *et al.*, 2000) and fermentation of the samples (Tiitinen *et al.,* 2006).

Taste. Panellists assessed the presence of sour taste and the taste acceptability of the couscous over the storage time. The sour taste of all the couscous samples were virtually negligible on the first day of preparation and were as follows; TDa 297 (0.38), TDa 98/01166 (0.69) and semolina (0.16). According to the judgment of the panellists, there was an increase in the sour taste after 8 weeks of storage to 1.7, 2.2 and 1 for TDa 297, TDa 98/01166 and

semolina couscous respectively. By the 24th week of storage, the sour taste had increased to 2, 2.5 and 1.05 for TDa 297, TDa 98/0166 and semolina couscous respectively.

Although the taste acceptability score of all the couscous samples were above average, generally TDa 297 couscous was better than semolina couscous. The taste acceptability score of TDa 98/01166 couscous was the least of the three samples assessed. The variability in the taste acceptability of the sample over the storage period was significant ($p < 0.05$).

Texture. The textural attributes of the products evaluated included stickiness, dryness, hardness and mouth feel. The stickiness of the samples on the first day was 3.3 and 2.97 for TDa 297 and TDa 98/01166 couscous respectively. These values were comparable to what was recorded for the semolina couscous (3.36). There was no consistent trend in the stickiness of the products. The 8th week recorded the lowest values of stickiness of 3, 2.8, and 3.11 for TDa 297, TDa 98/01166 and semolina couscous respectively. The stickiness of the samples could be attributed to the amount of free starch particles present in the couscous samples. It could also be dependent on the amount of the very small floury particles which may be present in the couscous samples. These free starch particles and smaller floury particles have been reported to contribute to the stickiness of moistened steamed couscous (Aboubacar and Hamaker, 1999).

There was a slight decrease in dryness of the samples with time. The dryness score averaged 3.15, 3.72 and 3.59 for semolina, TDa 98/0166 and TDa 297 couscous respectively. The results imply that the products were relatively moist; nevertheless, hardness and dryness were not significantly variable ($p > 0.05$).

The average score on mouth feel of the samples over the 24 week period were, 7.03, 5.2 and 5.33 for semolina, TDa 98/0166 and TDa 297 respectively. This implies that the mouth feel of semolina couscous is smoother than the yam couscous.

Overall acceptability. There was no significant difference in the overall acceptability score of the couscous, which were semolina (7.05), TDa 98/0166 (7.01) and TDa 297 (7). The overall acceptability of the yam couscous products was comparable to that of the wheat couscous. The slight increase in sourness and the slight darkening of the yam couscous did not affect the overall sensory attribute of the product during the 24 weeks of storage.

Sensory evaluation by couscous consumers at Paloma restaurant. TDa 297 couscous was used for this category of sensory analysis. The results obtained for the yam couscous was comparable to semolina couscous even though the semolina couscous was the most preferred choice of the panellists. The average score of colour of the semolina couscous and yam couscous were 8 and 5 respectively. This implies that the yellow colour of the semolina couscous was more appealing to the panellists than the off white colour of the yam couscous. The flavour score of 5 recorded by the yam couscous was lower compared to that of semolina couscous which recorded a value of 7. The scores of taste, stickiness, and overall acceptability were all 7 for semolina couscous and 6 for yam couscous.

Stickiness scored 7 for semolina couscous and 5.1 for yam couscous. This was an indication that stickiness of the semolina couscous was preferred to the yam couscous. On the whole, couscous from *D. alata* had comparable and acceptable qualities,

Conclusion

It can be concluded from this study that the moisture content, pH and the microbiological load of water yam couscous conforms to food standards for couscous. Yam couscous had similar sensory ratings as semolina couscous and was acceptable to the consumers over the storage period. It is therefore possible to produce couscous from *D. alata* which will be safe for human consumption and keep for not less than 24 weeks in a cool dry place.

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