Studies on the quality of traditionally smoked-dry snail meat (*Achatina achatina*) in Ghana

E. C. T. TETTEY, A. OSEI-YAW & M. HODARI-OKAE
Food Research Institute, CSIR, P.O. Box M.20, Accra, Ghana

SUMMARY

The quality of traditionally smoked-dry snail meat as it occurred on the open market in Ghana was investigated. Quality evaluation on representative samples of the product collected involved proximate composition, water rehydration capacity, microbiological and sensory analyses. A preliminary survey was also carried out to identify the processing procedure, raw material used, handling, packaging, and storage of smoked-dry snail meat. Results of the work indicated lack of hygienically controlled processing procedures, the use of poor quality snail meat for processing, and poor handling and storage procedures for the unpackaged smoked-dry product. The quality of the smoked-dry product was also generally poor based on results of microbiological and sensory evaluations. Recommendations for improving smoked-dry snail meat processing, including quality checks required to prevent recontamination and improve shelf-life and eating quality of the product, have been given.

Original scientific paper. Received 21 May 96; revised 7 Oct 97.

RÉSUMÉ

TETTEH, E. C. T., OSEI-YAW, A. & HODARI-OKAE, M.: *Les études sur la qualité de la chair d' escargot traditionellement fumée sèche*. La qualité de la chair d'escargot traditionellement fumée sèche comme elle se trouvait en vente libre au Ghana était enquêtée. L'évaluation de la qualité des échantillons représentatives du produit amassé implique la composition approximative la capacité d' hydratation d'eau, les analyses microbiologiques et sensorielles. Une levé s'est déroulé également pour identifier les procédures de préparation, les matières premières utilisées, la manutention, l'emballage et le stockage de la chair d'escargot fumée-séche. Les résultats d'oeuvre indiquaient un manque de procédures de préparation hygiéniquement-contrôlées, l'utilisation de chair d'escargot de la mauvaise qualité pour la préparation et des mauvaises procédures pour la manutention et le stockage pour le produit fumé-sèc non-emballé. La qualité du produit fumé-séc était aussi mauvaise dans l' ensemble, fondée sur les résultats d' évaluations microbiologiques et sensorielles. Les recommendations pour une préparation améliorée de la chair d'escargot fumée-sèche, y compris les contrôles de qualité exigés pour empêcher la recontamination et améliorer la durée de conservation avant vente et la qualité de l'alimentation du produit, ont été données.

Introduction

The problem of protein malnutrition or deficiency in the less-developed economies of Africa suggests the full exploitation by man of his environment to supply the need. In the humid tropics of Africa such as Ghana, livestock productivity of cattle, sheep and goats, among others. is low due to the lack of nutritious feed and clean water supply as well as to health problems. Animal sources that are traditionally acceptable but are as yet unexploited for commercial production, such as meat from small ruminants (including rodents, grasscutter, rabbits), land snails and even termites, may therefore form useful sources of animal protein for human consumption.

It is now accepted that mini-livestock such as snails, rodents, and other small livestock in the wild can substantially improve living conditions of both rural and urban populations by providing valuable protein supplement to the diet as well as generating additional income (Anon., 1992).

Graham (1978) also stated that snails form an important source of protein and iron in the diet of the forest-dwelling people in West Africa.

Current data on the extent to which bush meat contributes to the national diet of Ghanaians are lacking. However, there are ample data on work done in the past, including availability and consumption patterns of various meat sources such as bush meat in Ghana (Jollans, 1959; Clottey, 1968; Whitby, 1968; Asibey, 1969) and the nutritional information on wild animals as a source of food (Oracca-Tetteh, 1971; Asibey & Eyeson, 1975). In Ghana, edible snails, of the species *Achatina achatina* and *Archachatina degneri,* contribute substantially to total protein intake at least among low-income groups and rural dwellers, especially during the rainy season when snails are in abundance.

The snail meat is normally consumed in the fresh state after cooking in stews or soups, or preserved by smoke-drying skewed on sticks, which is usually consumed in soups. Snails are normally picked during the rainy seasons (from April to July and from August to September) and are abundant in the forest and humid zones of the country, i.e. Ashanti, Western, Eastern, and Brong-Ahafo Regions. In processing smoked-dry snails, the snails are deshelled and then cleaned of gut contents and skewed on specially prepared sharp sticks. The skewed meat is then heavily hot-smoked on fire previously prepared until the snail meat is well-dried, hard, and very dark. Periodic heat and smoke action is also given to the smoked snail meat to prolong its shelf life. Traditionally smoked- dry snail meat is not packaged when displayed for sale on open trays. At the end of the day, the unsold product is stored in baskets, sacks or wooden boxes.

There is ample contamination to the otherwise shelf-stable, smoked-dry product through human handling and from the surrounding environment. These factors limit product storage life and eating qualities.

The objective of this study was to examine the quality of traditionally smoked-dry snail meat sampled from various selling points and to design and recommend quality checks that will afford a more hygienically processed and preserved smoked-dry snail meat for consumption in Ghana.

Materials and methods

Five sample lots of traditionally smoked-dry snail meat were collected from the Kantamanto, Kaneshie, Mallamata, and 31st December Markets in Accra, Ghana, where the product was normally sold, and also from over 15 different sellers randomly chosen. The variability between the five sample lots of the product will, therefore, stem from the method of processing, handling, storage, and raw material used.

Analytical procedure

Each of the five sample lots of smoked-dry snail meat collected was thoroughly mixed together after removal from sticks on which they were skewed. The mixed sample lot was then divided into three groups and used separately for chemical and microbiological analyses, and for sensory evaluation as well as water rehydration capacity (WRC) determinations.

The following chemical analyses were carried out on smoked-dry snail meat according to AOAC (1990) procedures: moisture content, crude protein, total ash, total fat, and *p*H. Salt was determined by the Mohr method (Pearson *et al.*, 1981).

Microbiological analyses carried out were total viable counts, on Plate Count Agar at 37 °C for 24-72 h, and coliforms/faecal coliforms using MacConkey Broth/Agar respectively at 37 °C for 48 h (Thatcher & Clark, 1974).

Sensory analysis was carried out by a 12-member panel on cooked smoked-dry snail meat in a Ghanaian light soup (prepared from tomatoes, onions, and pepper blended together with the addition of water and salt to taste). All panel members were staff of the Food Research Institute, who were familiar with sensory evaluation, and the product to be tested.

Each sample was assigned a random three digit coded number and the coded samples were then

presented to panellists in a random order.

Each panellist simultaneously evaluated the five sample lots in a partitioned booth. Panellists were required to rinse their mouth with water between each sample-tasting. The coded samples were rated on a 5-point hedonic scale (Piggot, 1988) as follows: dislike extremely = 1; dislike slightly = 2; like slightly = 3; like moderately = 4; and like extremely = 5. The quality attributes tested for were odour, taste, tenderness (ease of mastication), off-taste or flavour, and overall acceptability. The WRC was carried out on sample to distilled water ratio of 1:5 for 1 h rehydration period under ambient conditions. After this period, the rehydrated snail meat was removed from the distilled water, the meat surface dabbed with tissue to remove surface water and then reweighed. Mean percent gain (or percent rehydration) of snail meat was then calculated (personal communication by courtesy of D.E. Silverside, Natural Resources Institute, Chatham, London) as follows:

$$\% \text{ rehydration} = \frac{\text{Mean weight gained} \times 100}{\text{Mean initial weight}}$$

Statistical analysis to determine differences between sample means was carried out using Tukey's Wholly Significant Difference (WSD) procedure at 5 per cent level of significance (Murdoch & Barnes, 1986).

Results and discussion

Significant differences ($P < 0.05$) occurred among mean moisture content values for smoked-dry snail meat (Table 1). These differences may reflect the varying degree of drying during processing of smoked-dry snails by different processors, and subsequently post-processing handling and storage conditions of the exposed end-product.

Smoked-dry snail meat is intensively hot-smoked and the degree of finish is mainly based on the personal experience and judgement of the processor.

Mean crude protein values also showed significant differences ($P < 0.05$). Crude protein value was expected to vary indirectly with the moisture content value of the sample, but this trend was not clearly shown. The importance of snail meat as a comparatively rich source of animal protein was indicated in this work. Mean crude protein values ranged between 50.04 to 56.25 per cent (Table 1). Graham (1978) also reported varying protein contents for snails from 37.0 to 51.3 per cent. Mead & Kemmerer (1953) and Oracca-Tetteh (1971) have also indicated higher arginine and lysine contents for snails than those of whole egg. These protein values, however, show a sharp contrast when compared with those for other meat animals such as smoked grasscutter (*Thryonomis swinderianus*), smoked mutton or salted beef which were respectively, 16.2, 21.0, and 14.7 per cent (Eyeson & Ankrah, 1975). These differences may, however, partly be attributed to the slightly higher moisture contents in these other meat samples.

Mean total ash values were not significantly different ($P > 0.05$) and ranged between 4.79 and 5.48 per cent, except for sample lot 111 which was 11.88 per cent. Eyeson & Ankrah (1975) also reported ash values for dried snails ranging

TABLE 1

Chemical Analyses on Smoked-Dry Snails

Analysis	*Mean value of sample groups*				
	I	*II*	*III*	*IV*	*V*
Total moisture (%)	14.39^{a}	12.54^{c}	13.16^{bc}	11.29^{d}	12.14^{bce}
Crude protein (%)	50.04^{a}	55.92^{b}	56.25^{bc}	54.69^{abc}	51.68^{abc}
Ash (%)	5.11^{a}	4.79^{a}	11.88^{b}	4.71^{a}	5.48^{a}
Salt (%)	0.24^{a}	0.15^{a}	0.23^{ab}	0.10^{ab}	0.27^{ab}
Water rehydration capacity (%)	45^{a}	42^{a}	47^{a}	48^{a}	48^{a}
*p*H	6.58^{a}	6.63^{a}	6.88^{b}	6.53^{a}	7.10^{bc}
Total fat (%)	3.61^{a}	3.49^{a}	4.06^{a}	3.71^{a}	4.08^{a}

Means in the same column followed by the same letter are not significantly different ($P<0.05$) according to Tukey's Wholly Significant Difference.

between 3.2 and 3.4 per cent. The significantly high ash value for sample lot 111 may be attributed to the snail shell or sand particles in the smoked-dry end-product. Ash value may be important because it indicates the total mineral content of the product, if not attributable to sand or other extraneous matter.

Significant differences occurred ($P<0.05$) among sample means for salt content, but the values were generally low. Smoked-dry snail meat is not normally salted during or after processing; therefore levels present may reflect natural contents.

The WRC values were low and showed no significant differences ($P>0.05$) among all sample means, indicating some similarity in the degree of drying (time and temperature) during processing.

The moisture content of the smoked-dry end-product also seemed to have, although not conclusively, a bearing on the WRC. Thus, generally, the lower the moisture content, the higher the rehydration capacity of the sample.

Total moisture content of smoked-dry snails ranged between 11.29 and 14.39 per cent.

The lower WRC values obtained may indicate charring or case-hardening effects due to excessive heat action during processing. These factors may affect the eating qualities of the end-product, notably the taste and texture.

Mean *p*H values were generally similar and towards neutrality, which may indicate the absence of any excessive protein break down activity, which would otherwise cause a rise in *p*H levels.

Mean total fat values were generally low, ranging between 3.61 and 4.08 per cent and not significantly different ($P>0.05$) among all sample means. This result indicates the leanness of smoked-dry snail meat. Eyeson & Ankrah (1975) also reported a similar fat content value for dried snail meat to be 3.0 per cent.

Total viable counts on smoked-dry snail meat (Table 2) indicated high contamination with spoilage micro-organisms in all sample lots analyzed, and especially for sample lot II. The low moisture content for smoked-dry snail in this study

TABLE 2

Microbiological Analysis on Smoked-Dry Snails

Sample	*Description*	*Total aerobic count/g*	*Mould yeast count/g*	*Direct culture*	*Coliforms in OIG sample*	*Faecal coli-form*
I	Dried sample with heavy patches of mould growth	2.68×10^9	4.38×10^4	Micrococci, *Bacillus*, *Penicillium* spp., *Aspergillus* spp.	Not present	Not present
II	Slight patches of mould growth	2.77×10^{18}	6.1×10^2	Micrococci, sporing *Bacillus*, *Mucor*, *Penicillium* spp.	do	do
III	Dried sample, no detectable mould growth	1.88×10^5	4.0×10^1	Micrococci, sporing *Bacillus*, Mucor spp.	do	do
IV	Dried sample, presence of mould growth	12.04×10^9	1.33×10^3	Micrococci, sporing *Bacillus, Penicillium* spp. *Aspergillus* spp.	Present	do
V	Dried sample, slight patches of mould growth	2.9×10^8	6.5×10^2	Micrococci, sporing *Bacillus, Mucor*, *Penicillium* spp.	do	do

indicates that high bacterial counts and to a lesser extent mould and yeast counts, and also the presence of spore-forming organisms may be attributed to surface post-processing contamination mainly through poor handling and storage practices. The coliforms in sample lot IV suggest contamination of the product with faecal matter through poor and unhygienic handling of the product.

Smoked-dry snails are displayed and sold on open trays without any form of packaging or protective covering. The product is, therefore, highly vulnerable to any contamination from the environment or by handling.

Conclusion

Traditionally smoked-dry snail meat can be considered to be a very stable product under tropical ambient conditions of storage, provided that the preserved end-product is protected from post-processing contamination through proper packaging, handling, and storage. However, results of this study showed the absolute lack of packaging for smoked-dry snail meat during display for sale or during storage and also poor handling practices, predisposing the end-product to contamination from the surrounding environment. Processing procedures, especially time and temperature control during hot smoking and the quality of raw material used, have also been identified to be poor. The overall effect was that the quality of smoked-dry snail meat on the open market during the study showed gross superficial microbiological contamination due to lack of packaging and poor handling. It also showed poor eating qualities, notably bitter taste and brittle feel when chewed, which suggests poor processing control (excessive heat and smoke application), and the possible use of poor raw material quality for processing.

Recommendations

The recommendations are to enable the prospective entrepreneur to produce "right first time" quality smoked-dry snail meat for the local market or possibly for export. With these guidelines, elaborate checks on microbiological, physical or chemical quality may be minimized except for routine checks such as moisture content, total viable counts, and raw material quality. The illiterate snail meat processors may be assisted through a demonstration unit, or series of workshops to enable them to acquire the skills in producing "right first time", to build up a better sense of judgement for time and temperature control during hot smoking, and also to achieve the desired degree of finish for the end-product.

The recommendations, based on results of this study, are as follows:

i. Moisture content for smoked-dry snail meat within the range of 10 to 14 per cent is suitable for shelf stability of the product, provided well packaged.
ii. The smoked-dry product must be packaged and aerobically sealed in low density polyethylene bags and kept away from humid conditions while in storage or on sale under ambient conditions. The long skewed smoked-dry snails on sticks may be broken up into shorter skews to allow for easy packaging.
iii. The product must be free from sand particles, snail shell or any extraneous matter. Par-boiling before snail meat extrusion from shell is recommended.
iv. Smoking grills must have at least 60 cm clearance from the fireplace below to prevent excessive heat uptake and charring of the snail meat during hot smoking. The fire place must also be well covered to prevent heat losses.
v. Fresh, live snails must be used as the starting raw material for processing. The use of dead snails in shells, semi-decomposed snails in shells or snails with crushed shells as raw material for processing must be avoided.
vi. Total viable counts must not exceed 10^6 per gram when properly processed, packaged, and stored.

vii. Smoked-dry snail meat must be devoid of coliforms or faecal coliforms at any time or point of the product after processing.

viii. The shelf-life under ambient conditions of properly and hygienically processed and packaged smoked-dry snail meat should be up to 6 months or more.

ix. *Ascaris sirus* mite infestation on smoked-dry snail meat during storage may be prevented with the afore-mentioned processing and storage guidelines.

REFERENCES

AOAC (1990) *Association of Official Analytical Chemists*, 5th ed. Vol.II.

Anon. (1992) BEDIM (Bureau for Exchange and Distribution of Information on Mini-Livestock). Technical Centre for Agriculture and Rural Co-operation ACP-EEC-CTA. Wageningen. The Netherlands.

Asibey, E. O. A. (1969) *Wild animals and Ghana's economy.* (An investigation into bushmeat as a source of protein (unpublished data).

Asibey, E. O. A. (1970) *Grasscutter* (Thryonomys swinderianus) *as a source of bush meat in Ghana* (unpublished data).

Asibey, E. O. A. & Eyeson, K. K. (1975) Additional information on the importance of wild animals as a food source in Africa south of the Sahara. *Bongo (Ghana Wildlife Society)* **1** (2), 13-18.

Clottey, St. J. (1968) Production and utilization of animal products in Ghana. *Food Res. Inst. tech. Rep.*

Eyeson, K. K. & Ankrah, E. K. (1975) *Composition of foods commonly used in Ghana.* Food Res. Inst. and UNDP/FAO Project. Food Res. Insti., CSIR Publ.

Graham, S. M. (1978) *Seasonal influences on the nutritional status and iron consumption of a village population in Ghana* (M Sc Thesis). University of Guelph, Canada. As referenced by **Hodasi** (1984) in *World Animal Review* **52**, 24-28.

Jollans, J. L. (1959) Meat preference of people in the Central Region of Ghana. *J. West Afr. Sci. Assoc.* **5,** 64.

Mead, A. R. & Kemmerer, A. R. (1953) Amino acid content of dehydrated giant African snails (*Achatina fulica*). *Bowdicha Sci.* **117**, 138-139. As referenced by **Hodasi** (1984) in *World Animal Review*, **52**, 24-28.

Murdoch, J. & Barnes, J. A. (1986) *Statistical tables for science engineering, management and business studies*, 3rd ed., Tables 9 and 11. London: Macmillan Education Ltd.

Oracca-Tetteh, R. (1971) The gaint African snail as a source of food. As referenced by **Hodasi** (1984) in *World Animal Review*, **52**, 24-28.

Pearson, D., Egan, H., Kirk, R. S. & Sawyer, B. (1981) *Chemical analysis of foods*, 8th ed. London: J. and A. Churchill.

Piggot, J. R. (1988) *Sensory analysis of food*, 2nd ed. London: Elsevier Applied Science.

Thatcher, F. S. & Clark, D. S. (1974) *Micro-organisms in foods* (II). Toronto, International Commission on Microbiological Specifications for Foods (ICMSF). University of Toronto Press.

Whitby, P. (1968) Foods in Ghana. *Food Res. Inst. Bull.* **1**, 24.