Riboflavin content of some fermented foods of Ghana

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SUMMARY

Levels of riboflavin in maize (*Zea mays*) dough and cassava (*Manihot utilissima*) mash during various stages of fermentation were determined. The effects of traditional methods of processing and preparing some foods from these products were also investigated. The level of riboflavin in both maize dough and cassava mash remained almost unchanged over 4 days of fermentation, being respectively about 0·107 and 0·030 mg riboflavin per 100 g dry matter for maize dough and cassava mash. Cooking maize dough into *banku* and *Ga kenkey* resulted in a mean loss of 33% and 36% riboflavin respectively. There was no significant change in the riboflavin level in *gari* made from cassava mash. Information is also given on the riboflavin content of *pito* and palm wine.

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RÉSUMÉ

ANKRAH, E. K.: *Teneur en riboflavine de quelques aliments fermentés, au Ghana.* L'auteur a déterminé les teneurs en riboflavine de pâte de maïs (*Zea mays*) et de bouillie de tapioca (*Manihot utilissima*) au cours de différents stades de fermentation. Les effets des procédés et méthodes de préparation de quelques plats provenant de ces deux substances ont également été étudiés. La concentration en riboflavine dans la pâte de maïs comme dans la bouillie de tapioca, est restée à peu près inchangée après 4 jours de fermentation, soit respectivement pour chacune d'elles, de 0,107 et 0,030 milligr. de riboflavine par 100 gr. de matière sèche. La cuisson de la pâte de maïs pour en faire du banku ou du Ga kenkey a déterminé une perte de riboflavine, respectivement de 33% et de 36%. La transformation en gari de la bouillie de tapioca n'a pas produit de réduction sensible de la riboflavine. Des informations ont également été obtenues sur la teneur en riboflavine du pito et du vin de palme.

Introduction

The result of a dietary survey conducted in Ghana (Whitby, 1968) appeared to show that the dietary intakes of riboflavin were generally inadequate, and that deficiency signs were commonly encountered. Only 75% of the riboflavin requirement is obtained through food consumption.

With the riboflavin deficiency state in mind, the present study was made in order to evaluate possible changes of riboflavin content of some Ghanaian staples during fermentation. This involved the measurement of riboflavin levels in maize dough and also in the mash obtained from sweet red-skinned cassava tuber during various stages of fermentation. The effect of traditional processing and preparation on the riboflavin levels in these foods was also investigated. Finally, the riboflavin content of some alcoholic drinks, pito and palm wine, were measured.

Materials and methods

Sample preparation and analysis

Maize dough and maize products. Eight samples of maize, *Zea mays* (white variety), each weighing about 5 kg, were bought from different vendors in Accra. Each sample was soaked for about 48 h at room temperature (26·5–29·5 °C). The grains were ground into a meal which was kneaded into a dough with about one litre of water. The dough was left to ferment adventitiously at room temperature for 4 days.

For each sample, a small portion of the top slimy yellowish layer was removed, and a representative portion of the dough was obtained by pressing a spoon transversely down the dough to scoop out

about 30 g which was then mixed thoroughly. Riboflavin content of a 10 g portion and moisture content of a further 5 g portion were determined. This procedure was repeated each day over the next 4 days of fermentation for each maize dough sample.

One quarter of the dough was removed on the 1st, 2nd, 3rd and 4th days of fermentation so that the rest of the dough was not disturbed. Half of the dough so removed was cooked into *banku* and the other half into *Ga kenkey* as follows: To prepare banku about 200 ml of water was added to about 160 g dough. This was stirred and cooked into a soft consistency. To prepare Ga kenkey, 400 g of dough was added to about 500 ml of water, and was partially cooked to produce *aflata*. Then about 400 g of uncooked dough was added to the aflata. The mixture was moulded into balls and wrapped in corn husks. The balls were cooked in about 3 l of water (hereinafter referred to as Ga kenkey cooking water).

A slice about 2 cm thick was cut transversely from the Ga kenkey and mashed in a mortar. Riboflavin content of a 10 g portion and moisture content of a further 5 g portion of each of banku and Ga kenkey samples were determined. The Ga kenkey cooking water was shaken well, and the riboflavin content of a 40 ml portion was measured.

Cassava mash and cassava products. Twelve samples of sweet, red-skinned cassava (*Manihot utilissima*) each weighing about 2 kg were bought from markets in Accra. For each sample, the tubers were peeled and grated into a mash. The mash was placed in white cloth and squeezed manually to extract the juice. A 10 kg weight was then placed on the mash in the cloth to squeeze out further juice as fermentation proceeded. The mash was left to ferment spontaneously at room temperature (about 28 °C) for 4 days. At the end of the 4th day, the mash was sifted to remove the coarse granules, and the fines were roasted in an open pan, with constant stirring, into gari.

Riboflavin content of a 10 g portion each was determined for the fresh mash, the mashed samples collected after each day of fermentation and the cassava juice. For the determination of riboflavin content of gari 5 g portion of gari was used. Moisture content was determined for the fresh mash, the mash samples collected after each day of fermentation and gari.

Palm wine and pito. Nine samples of palm wine and 10 samples of pito were bought from different vendors in Accra. After the samples were shaken well, the riboflavin content of a 10 ml portion of each was determined. The total solids in a 5 g portion of each were also determined.

Method of analysis

Riboflavin. Riboflavin determinations were performed by the fluorometric method of Arnold (1945) using Coleman Model 12C electronic photofluorometer. The procedure is a slight modification of the method of A.O.A.C. (1970). The riboflavin content was calculated on moisture-free sample.

Moisture. Moisture content was determined by drying 5 g of sample in an oven at 105 °C to constant weight. The moisture content was calculated as the difference between the wet weight and the dry weight.

Total solids. The total solids content was determined by drying 5 g of sample in an oven at 105 °C to constant weight.

Results and discussion

Table 1 shows that the riboflavin level of maize dough remained almost unchanged over the 4 days of fermentation being around $0{\cdot}107 \pm 0{\cdot}005$ mg riboflavin per 100 g dry matter. However, when the maize dough was cooked into banku and Ga kenkey, the riboflavin levels were $0{\cdot}071 \pm 0{\cdot}019$ and $0{\cdot}068 \pm 0{\cdot}014$ mg per 100 g dry weight of sample respectively. This amounted to mean losses of 33% for banku and 36% for Ga kenkey. The Ga kenkey cooking water contained $0{\cdot}062 \pm 0{\cdot}022$ mg riboflavin per litre. This is an indication that leaching of about 13% riboflavin from the Ga kenkey into the surrounding cooking water occurred. On the basis of this observation the practice of drinking Ga kenkey cooking water is commended.

When the cassava mash was subjected to 4 days of fermentation, the riboflavin content was steady at a mean value of 0·030 mg riboflavin per 100 g dry weight of sample as shown in Table 2.

Gari made from the 4-day old fermented cassava mash contained $0{\cdot}032 \pm 0{\cdot}004$ mg riboflavin per 100 g dry gari compared with $0{\cdot}029 \pm 0{\cdot}001$ for the mash showing no significant change

TABLE 1

Riboflavin and Moisture Contents of Maize Dough, Banku, Ga Kenkey, and Ga Kenkey Cooking Water

Name of food sample	*Maize dough* [8]					*Banku* [31]	*Ga kenkey* [28]	*Ga kenkey*† *cooking water* [31]
	Days of fermentation							
	0	*1*	*2*	*3*	*4*			
Riboflavin content* (mg/100 g dry matter)	0·107±0·011	0·100±0·011	0·108±0·009	0·107±0·005	0·106±0·004	0·071±0·019	0·068±0·014	0·062±0·022
Moisture content (%)	51·6 (50·7–52·5)	50·5 (50·1–51·5)	50·4 (50·1–51·8)	49·0 (48·1–49·5)	48·0 (46·8–48·8)	66·8 (62·0–69·5)	69·1 (61·0–71·5)	

Figures in square brackets represent number of samples analysed.
Figures in parentheses are the range values.
* The values represent the mean and standard deviation.
† The riboflavin content has the unit mg/litre of wet sample.

TABLE 2

Riboflavin and Moisture Contents of Cassava Tuber Mash, Cassava Juice and Gari

Name of food sample	*Cassava mash* [12]					*Gari*‡ [12]	*Cassava juice*† [12]
	Days of fermentation						
	0	*1*	*2*	*3*	*4*		
Riboflavin content* (mg/100 g dry matter)	0·030±0·003	0·032±0·005	0·030±0·001	0·031±0·005	0·029±0·001	0·032±0·004	0·025±0·006
Moisture content (%)	58·3 (55·0–63·0)	53·1 (49·0–57·2)	53·6 (51·0–57·9)	52·0 (50·0–54·0)	51·7 (50·0–53·8)	6·5 (3·2–11·6)	

Figures in square brackets represent number of food samples analysed.
Figures in parentheses are the range values.
* Figures represent the mean and standard deviation.
† Riboflavin was measured as mg/100 g cassava juice extracted from the fresh cassava mash.
‡ *Gari* was prepared from the 4-day-old fermented cassava mash.

TABLE 3

Riboflavin and Total Solids Contents of Pito and Palm Wine

Name of alcoholic beverage	*Pito* [*10*]	*Palm wine* [*9*]
Riboflavin (mg/litre)*	0·21±0·07 (0·12–0·37)	0·15±0·01 (0·12–0·18)
Total solids (%) (w/v)	4·32 (2·86–5·80)	2·45 (1·67–3·32)

Figures in square brackets represent number of samples analysed.

Figures in parentheses are the range values.

* The values represent the mean and standard deviation.

in the riboflavin level. The cassava juice was found to contain a mean of 0·025±0·006 mg riboflavin/100 g net weight.

The market samples of pito contained 0·21± 0·07 mg riboflavin per litre and a mean of 4·32% total solids (w/v) as shown in Table 3. Analysis of one sample of pito prepared in the laboratory gave 0·42 mg riboflavin per litre with 16·4% (w/v) total solids. This could mean that probably the market samples were diluted before sale. The palm wine samples were found to contain smaller amount of riboflavin than the pito samples. The palm wine samples contained 0·15±0·01 mg riboflavin per litre as compared with 0·11 mg riboflavin per litre for ½ to 1-day old palm wine reported by Leong (1953) and 0·24 mg riboflavin per litre for 1 to 2-day old observed by Heard (1955).

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REFERENCES

Arnold, A. (1945) Report of the 1944–45 Committee of Riboflavin Assay. *Cereal Chem.* **22,** 455.

A.O.A.C. (1970) *Methods of analysis*, 11th ed., pp. 774–775. Washington, D.C.: Association of Official Agricultural Chemists.

Heard, C. R. C. (1949) Chemical composition of palm wine. *Bull. Natal Soc. Preserv. wild Life Oct.–Feb.* p. 4.

Heard, C. R. C. (1955) Palm wine in human nutrition (Abstr.) *Proc. Nutr. Soc.* **14,** xi–xii.

Leong, P. C. (1953) The nutritive value of coconut toddy. *Br. J. Nutr.* **7,** 257.

Whitby, P. (1968) *A review of information concerning food consumption in Ghana.* Accra: Food Research & Development Unit and Food Research Institute.