Chemical composition and nutrient balance of Busaa, a Kenyan opaque maize beer

Chemie, Mikrobiologie, Technologie der Lebensmittel

Nout, M.J.R.

1647

CMTL

Chemie Mikrobiologie Technologie der Lebensmittel

FOOD CHEMISTRY MICROBIOLOGY TECHNOLOGY

Sonderdruck aus

Chem. Mikrobiol. Technol. Lebensm. **11**, 51-55 (1987)

Chem. Mikrobiol. Technol. Lebensm. **11**, 51-55 (1987)

Chemical Composition and Nutrient Balance of Busaa, a Kenyan Opaque Maize Beer

M. J. R. Nout

Department of Food Science and Technology, University of Nairobi, Kabete, Kenya

Received January 9, 1987

Summary

The chemical composition of Busaa, a traditional Kenyan opaque beer from maize and finger millet was analysed and compared with that of similar products.
A nutrient dry matter balance was determined during the course of pilot-scale Busaa manufacture.
Whereas losses of protein, energy, P, Ca, vitamin B_1, and niacin were observed, the traditional manufacturing process resulted in significant gains of Fe, vitamins B_2 and B_{12}, and pantothenic acid.
Whereas the increased Fe content originated from the processing equipment used, the synthesis of vitamins could be attributed to the fermentation stages involved and, in the case of pantothenic acid, to the germination (malting) of finger millet.

Chemische Zusammensetzung und Nährstoffbilanz von Busaa, einem trüben Maisbier aus Kenia.

Zusammenfassung: Die chemische Zusammensetzung von Busaa, einem traditionellen trüben Bier aus Mais und Fingerhirse in Kenia wurde analysiert und mit der ähnlicher Produkte verglichen.
Während der aufeinanderfolgenden Herstellungsstadien von Busaa wurde eine Nährstoffbilanz erstellt.
Im Verlauf des traditionellen Herstellungsverfahrens wurden Verluste von Eiweiß, Energie, P, Ca, Vitamin B_1 und Niacin, aber auch signifikante Zunahmen von Fe, den Vitaminen B_2 und B_{12} und Pantothensäure beobachtet.
Während die Zunahme des Fe-Gehaltes vom Gebrauch saurer Ingredientien in eisernen Behältern herrührt, kann die Synthese von Vitaminen vermutlich den einzelnen Stadien der Fermentation und, im Fall der Pantothensäure, insbesondere dem Keimungsprozess der Finger-Hirse zugeschrieben werden.

Introduction

Microbiological, processing and preservation aspects of the manufacture of Busaa, an opaque maize beer made from maize and finger millet, were reported earlier [1-3].
In view of their role in the African diet, traditional beers like Busaa are regarded as a food [4, 5] rather than an intoxicating beverage. Their relatively high content of B-vitamins [6, 7] would be of importance considering wide-spread deficiencies of vitamins A and B_2, and Calcium in Southern Africa [6] and Kenya [8, 9].
Others [4, 10, 11] have studied the fate of nutrients from raw materials, when

processed into opaque maize and sorghum beers. It was invariably observed that the processes resulted in a considerable increase of the vitamin B_2 content, whilst increased vitamin B_1 and niacin contents were reported occasionally [4, 10].

Périssé [11], on the other hand, reported an increased vitamin B_{12} content in Togolese sorghum beer, when compared with the vitamin content of its ingredients. Such favourable enrichments, resulting mainly from vitamin synthesis by the microorganisms present during fermentations, have been described by Platt [7] as 'biological ennoblement' of foods.

During the manufacture of Affouk, a sorghum beer of Cameroon, considerable gains (on dry matter basis) of vitamin B_1 (67%), vitamin B_2 (315%) and niacin (37%) were reported [10]. During this process the losses of energy (19%) and crude protein (28%) were rather low compared with those reported in the manufacture of another sorghum beer, Amgba [10], and those calculated for Kaffir sorghum beer production [4].

Because of the apparently similar manufacturing processes of Affouk and Busaa, the following analyses were carried out to study the fate of selected nutrients from maize and finger millet during the production of Busaa.

Materials and Methods

Samples

Samples of Busaa, its ingredients and intermediate products were obtained, with the assistance of a commercial Busaa brewer, from 5 traditional style brewing cycles carried out in the pilot-plant of the Department of Food Science and Technology, University of Nairobi, according to the process described earlier [2]. Data presented are mean values of 5 samples each.

Analyses

Dry matter was determined by drying to constant weight at 105°C.

Crude protein, crude fat, crude fibre, ash, alcohol, Ca, Fe, and P were determined according to A.O.A.C. methods 2.055, 7.061, 7.070, 10.053 and 14.006, 11.005, 2.126, and 7.123, resp. [12].

Carbohydrate content was calculated by difference.

Energy content was calculated from proximate analyses, using the following factors: 17 kJ, 38 kJ, 17 kJ and 29 kJ per gram of protein, fat, carbohydrate and alcohol, resp. [13].

Vitamins B_1 and B_2 were determined by HPLC with fluorometric detection [14].

Niacin was determined by bio-assay with **Lactobacillus plantarum** [15].

Vitamin B_{12} was determined by competitive protein binding [16].

Pantothenic acid was determined by bioassay with **Lactobacillus plantarum** [17].

Results and Discussion

Table 1 lists the chemical composition of Busaa together with mean values of similar products published elsewhere [4, 6, 10, 11, 18, 19]. The differences between the composition of Busaa and the mean values for opaque beers are caused by variations in ingredients used, their formulation, and processing conditions employed.

The higher energy content as well as the higher crude protein, crude fat, carbohydrate, and ash contents are in agreement with the higher dry matter content of Busaa, compared with that of the average opaque beers. In this context, it should be realised that the composition of Busaa or any other beer is brewer-dependant, particularly with regard to formulation and processing.

Busaa contained much more Ca and Fe compared with the mean values for opaque beers. The reason for this will be analysed below.

The vitamin B_1, B_2, and niacin contents of Busaa were within the range of values for opaque beers listed in Table 1. On the other hand, higher values of vitamin B_{12} and pantothenic acid were obtained than reported in the literature. However, it should be noted that the values of the latter vitamins listed in Table 1 come from one source [11] only, which dealt with beer made from a different cereal, namely sorghum.

In Table 2, the nutrient content of a batch of Busaa is compared with that of the quantity of maize meal and finger millet grain required for its manufacture. Table 2 shows that there were

Table 1 Chemical composition per 100 g of Busaa compared with published data of African opaque beers made from maize, sorghum and/or millets.

	Busaa (passes 400 micron sieve)	African opaque beers (compiled literature data, sources: [4,6,10,11,18,19]) mean	range
energy (kJ)	292	155	130 -185
dry matter (g)	10.2	7.9	4.3 - 13.7
insoluble dry matter (g)	4.5	3.9	
crude protein (N x 5.7) (g)	1.55	0.59	0.27 - 1.09
crude fat (g)	0.65	0.06	0 - 0.3
crude fibre (g)	1.04	n.p.	
carbohydrate (g)	6.96	4.8	3.0 - 8.0
ash (g)	0.55	0.25	0.18 - 0.30
alcohol (g)	4.22	2.9	2.1 - 3.9
pH	3.60	3.40	
acidity (% w/v lactic acid)	0.99	n.p.	
Ca (mg)	18	2.2	1.0 - 4.0
P (mg)	82	39	7 - 63
K (mg)	n.d.	84	74 - 94
Na (mg)	n.d.	1.1	0.9 - 2.3
Fe (mg)	12	2.5	0.6 - 4.5
vitamin B_1 (mg)	0.05	0.11	0.03- 0.39
vitamin B_2 (mg)	0.03	0.05	0.04- 0.06
niacin (mg)	0.46	0.43	0.32- 0.60
vitamin B_{12} (µg)	0.09	0.03	
pantothenic acid (mg)	0.44	0.09	
vitamin C (mg)	n.d.	0.04	

n.d. = not determined, n.p. = not published

Table 2 Nutrient dry matter balance of Busaa manufacture.

	INPUT maize meal (5.0 kg)	INPUT finger millet grain (1.15 kg)	INPUT total input	OUTPUT Busaa (17.1 kg)	OUTPUT Gain/Loss (% of total input)
crude protein (g)	399	64	463	265	- 43
energy (kJ)	75100	15525	90625	49932	- 45
P (mg)	17150	2473	19623	14022	- 29
Fe (mg)	350	932	1282	2244	+ 75
Ca (mg)	400	5060	5460	3078	- 44
vitamin B_1 (mg)	37.5	1.61	39.11	8.55	- 78
vitamin B_2 (mg)	2.5	0.35	2.85	5.61	+ 97
niacin (mg)	95	7.13	102.13	78.66	- 23
vitamin B_{12} (µg)	<2.5	5.18	<7.68	16.83	> +119
pantothenic acid (mg)	32.5	5.06	37.56	82.28	+119

Table 3 The fate of iron, vitamin B_2, vitamin B_{12} and pantothenic acid during the manufacture of Busaa.

MANUFACTURING STAGE	Quantity of product (kg)	TOTAL CONTENT Fe (mg)	vitamin B_2 (mg)	vitamin B_{12} (µg)	pantothenic acid (mg)
maize meal ↓	5.0	350	2.50	<2.50	32.50
fermented maize slurry (fermented for 3 days) ↓	9.8	294	4.90	5.88	43.12
roasted fermented maize	8.5	2125	3.40	5.10	41.65
finger millet grain ↓	1.15	932	0.35	5.18	5.06
finger millet malt	0.85	519	0.34	5.27	24.82
beer mixture, fresh ↓	22.4	2637	2.24	11.18	64.82
beer mixture (fermented for 3 days) ↓	21.5	2623	8.60	17.20	86.00
Busaa beer, filtered	18.7	2244	5.61	16.83	82.28

significant losses of crude protein, energy, P, Ca, vitamin B_1, and niacin. These losses, which occur in any brewing process, result from various factors such as leaching, heating, respiration and filtration.

With regard to Ca, it should be noted that in spite of the losses due to filtration, the extremely high Ca content of finger millet is responsible for the higher-than-average Ca content of the final product.

Interestingly, a considerable increase of the Fe, vitamin B_2, vitamin B_{12}, and pantothenic acid contents takes place during the manufacturing process of Busaa.

Of the latter components, a more detailed balance is presented in Table 3. With regard to Fe, it shows that during the roasting operation a considerable amount of Fe is added to the processed maize. This can be explained from the heating and shoveling of the acidic mass of fermented maize in a roasting pan made of rusty galvanised iron sheet.

During the first processing stage, viz. the fermentative souring of the maize slurry, microbial activity results in significant increases of the vitamin B_2, Vitamin B_{12} and pantothenic acid contents. Only a fraction of these vitamins is destroyed during the subsequent roasting process.

Whereas the malting of finger millet does not result in noticeable changes in its vitamin B_2 and B_{12} contents, a significant increase in the level of pantothenic acid can be observed. Since the germinated finger millet also has a high microbial total count of $>10^7$/g, dominated by lactic acid bacteria [1], it is not possible to ascribe the production of pantothenic acid to either the germination of the finger millet seeds or the microbial activity during the soaking and germination steps.

During the final fermentation of the beer, a further increase in vitamin B_2, vitamin B_{12}, and pantothenic acid contents takes place, most likely as a result of microbial activity.

Inevitably, a certain quantity of the vitamins present in the beer mixture is removed during the final filtration. Vitamin B_2 appears to be affected most by this operation.

In Table 1 it was shown that, from a

nutrition point of view, Busaa has a superior chemical composition compared with similar African traditional beers. However, in the course of its manufacture considerable wastage of micro- and macro-nutrients takes place as shown in Table 2. Since particularly maize is the major staple food in Kenya, widespread traditional brewing could present an undesirable challenge to the national food security. Measures to control traditional brewing, and further research on reduction of wastage are required.

Acknowledgement

The determination of vitamins B_1, B_2, B_{12}, niacin, and pantothenic acid by Dr. W. H. P. Schreurs, CIVO-TNO, Zeist, The Netherlands, is gratefully acknowledged.

References

[1] Nout, M. J. R., Chem. Mikrobiol. Technol. Lebensm. **6**, 137 (1980)
[2] Nout, M. J. R., Chem. Mikrobiol. Technol. Lebensm. **6**, 175 (1980)
[3] Kretschmer, K. F., Monatsschr. Brauerei **34**, 41 (1981)
[4] Aucamp, M. C., Grieff, J. T., Novellie, L., Papendick, B., Schwartz, H. M., and Steer, A. G., J. Sci. Fd. Agric. **12**, 449 (1961)
[5] Platt, B. S., Proc. Nutr. Soc. **14**, 115 (1955)
[6] Goldberg, L. and Thorp, J. M., S. Afr. J. Med. Sci. **11**, 177 (1946)
[7] Platt, B. S., Food Technol. **18**, 662 (1964)
[8] Bohdal, M., Gibbs, N. E. and Simmons, W. K., Report to the Ministry of Health of Kenya on the WHO/FAO/UNICEF assisted project: Nutrition survey and campaign against malnutrition in Kenya, 1964-1968
[9] Van Steenbergen, W. M., Kusin, J. A., Voorhoeve, A. M. and Jansen, A. A. J., Trop. geogr. Med. **30**, 502 (1978)
[10] Chevassus-Agnes, S., Favier, J. C. and Joseph, A., Cahiers de Nutrition et de Diététique **11**, 89 (1976)
[11] Périssé, J., Adrian, J., Rérat, A. and LeBerre, S., Annls. Nutr. Aliment. **13**, 1 (1959)
[12] Williams, S., Official methods of analysis of the Association of Official Analytical Chemists, 14th ed., The A. O. A. C., Arlington, Virginia 1984
[13] Anon., Voeding, Neth. J. Nutr. **39**, 366 (1978)
[14] Van de Weerdhof, T., Wiersum, M. L. and Reissenweker, H., J. Chromatogr. **83**, 455 (1973)
[15] Anon., Difco Labs. Technical Bulletin No. 0247, 29 (1977)
[16] Richardson, P. J., Favell, D. J., Gidley, G. C. and Jones, G. H., Analyst **103**, 865 (1978)
[17] Anon., Difco Labs. Technical Bulletin No. 0247, 32 (1977)
[18] Platt, B. S., Tables of representative values of foods commonly used in tropical countries, Medical research council special report series No. 302, Her Majesty's Stationery Office, London 1962
[19] Woot-Tsuen Wu Leung, Food composition table for use in Africa, U.S. Department of Health, Education and Welfare, Food Consumption and Planning Branch, Nutrition Division, F. A. O., Rome 1968

Address of author:

M. J. R. Nout

Landbouw Universiteit Wageningen
Sectie Levensmiddelenchemie en -Microbiologie, Vakgroep Levensmiddelen technologie
'Biotechnion' De Dreijen 12
6703 BC Wageningen
The Netherlands