African Journal of Biotechnology Vol. 12(13), pp. 1517-1522, 27 March, 2013
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB12.1694
ISSN 1684–5315 ©2013 Academic Journals

Full Length Research Paper

Proximate composition of traditional local sorghum beer "dolo" manufactured in Ouagadougou

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Accepted 9 November, 2012

Dolo is a local beer manufactured from malted sorghum grains. It is the most commonly consumed alcoholic beverage in Burkina Faso (60% of population). Thirty (30) samples of dolo were collected from local markets in Ouagadougou and analyzed with respect to their proximate compositions and pH values using biochemical standard method. The average values of pH, dry matter and insoluble matter among samples were respectively 3.50±0.07, 5.90±1.24% (w/v) and 0.85±0.32% (w/v). Alcohol content in dolo samples was on average 2.30±0.25% (v/v). The total proteins, total carbohydrates and reducing sugars were 26±14.8, 38±20.4 and 10±3.8 µg/ml, respectively. The lipids were detected as traces in all dolo samples. The energetic value of dolo was on average 21.8±1.6 Kcal/100 ml of which these parameters characterize the quality of dolo.

Key words: *Sorghum bicolor*, local beer, dolo, alcohol content, composition, Burkina Faso.

INTRODUCTION

Alcohol consumption is a widespread phenomenon throughout the world and represents one of the most pressing global health priorities (Casswell and Thamarangsi, 2009). In Africa, the most beverages consumed were traditional manufactured and quality was not usually controlled. The studies on the biochemical composition and nutritional properties of local sorghum beers are very scarce. Dolo is a local beer, manufactured from malted red sorghum grains. It is a popular alcoholic drink in West Africa, particularly in Burkina Faso (Sawadogo-Lingani et al., 2007). Dolo is the most commonly consumed alcoholic beverage (60% of population) in Burkina Faso where 75% of the total sorghum grain production is used for its preparation (Sawadogo-Lingani et al., 2007).

Brewing of dolo is a long and complex process, which include several steps (Sawadogo-Lingani et al., 2007). In a general way, these processing steps are almost the same with brewing of industrial beer such as malting, massing, fermentation, filtration and conditioning (Figure 1). Malting is used to germinate the sorghum grains. The objective was to activate synthesis of hydrolytic enzymes (α-amylases, β-amylases, proteases, etc). Massing is the stage at which starch and the proteins are converted by endogenous hydrolases into fermentable sugars and peptides, respectively. During the massing step, local brewers usually incorporate in the mixture some mucilages obtained from the soaking bulbs of *Abelmochus esculentus*, *Curculigo pilosa, Gladiolus klattianus*, or leaves of *Adansonia digitata*, *Boscia senegalensis*, *Grewia bicolor*, etc (Dicko et al., 1999; 2000; 2001; Sawadogo-Lingani et al., 2007); soaking permits the release of enzymes contained in vegetables bulbs or leaves. Sorghum beer is often brewed using extracts of bitter vegetables to impart a bitter taste and flavour as substitutes for hops used for lager beer production (Adenuga et al., 2010).

After saccharification, the wort is boiled for approximately 12 h. This step allows desactivation of the enzymes and precipitation of insoluble matters. Prior to the alcoholic fermentation, the wort is incubated with a portion

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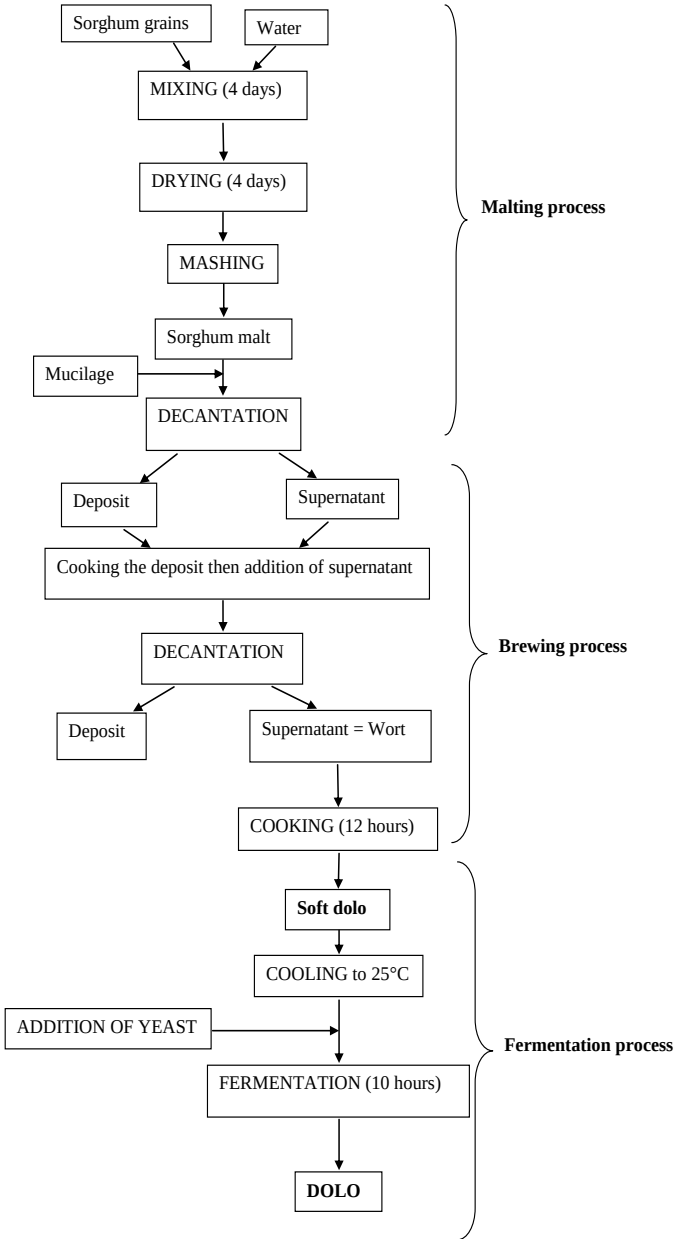

Figure 1. Steps of local sorghum beer "dolo" processing in Burkina Faso.

portion of previous brew or dried yeast harvested (Sefa-Deheh, 1999). Fermentation is the conversion of fermentable sugars into alcohol and carbon dioxide (Fossati, 2004). The wort in fermentation is in agitation due to the release of carbon dioxide and foam. After fermentation, the resulting dolo beer is narrowly filtered so that some yeast may still remain in the final product. This process has a negative consequence on the preservation of dolo because a slow fermentation continues after dolo conditioning and during its sale (Mandjeka, 2002). Dolo is conditioned in barrels and is conveyed to the places of sale. It may be preserved in cans hermetically closed for approximately three days at room temperature and more if it is stored at low tempera-ture. The different processes used for dolo production affect probably its compound and nutritional quality and needed biochemical control.

The aim of the present work was to evaluate the proximate compounds of dolo in the way to appreciate the related nutritional quality.

MATERIALS AND METHODS

Sampling

Thirty (30) samples of dolo (500 ml for each sample) were collected from dolo manufacturers, starting from September to October 2009, in various areas of the city of Ouagadougou, Burkina Faso. Samples were kept on ice at 0°C and routed until the laboratory analyses. Prior to analyses, dolo samples were stored in the laboratory at -30°C. Dolo manufacturers in Ouagadougou were selected according to their geographical distribution. Sampling was carried out in 15 sectors of Ouagadougou (12.4° N 1.5° W) of which two samples were collected from each area.

Measure of pH values

The pH values of each dolo samples were taken after collection and before conservation at -30°C. The pH values were measured by a pH-meter with digital display (WTW multi line P4) calibrated with standard buffers (AOAC, 1990).

Dry matter

The dry matter was determined by desiccation of 5 g of each dolo samples in an oven at 105°C. After cooling in a desiccator until obtaining a constant weight, the sample was weighed (AOAC, 1990). The weights were determined using an electronic balance (Denver Instrument Company).

Insoluble matter

To quantify the insoluble matter contained in dolo samples, empty tubes of centrifugation were weighed. Then, aliquots of 10 ml of each dolo samples were put in each tube and centrifuged at 4000 rpm for 1 h. After shrinkage of the centrifugal apparatus tubes, the supernatants were removed. After drying, the tubes containing the deposits were weighed. The difference between the weights of initial and final centrifugation tubes is referred to us as insoluble matter (AOAC, 1990).

Total alcohol content

Alcohol content was measured by determination of the density of alcohol extracts from dolo samples and then referring to the Tafel table. Dolo samples were first degassed with ultrasound tanks for fast removal of gas from liquids. Decarbonated dolo samples (50 ml) were then taken and put in a distillation balloon. Afterward, 50 ml of distilled water were added. The water-alcohol mixture was distilled and 50 ml of the distillate were recovered in a flask, then a clean and dry pycnometer was prepared. After determining its empty weight, the pycnometer was filled with the distillate and then weighed. A pycnometer filled with distilled water was used as a control blank. The degree of alcohol was read directly from the Tafel table (Humphrey and Okafoagu, 2007).

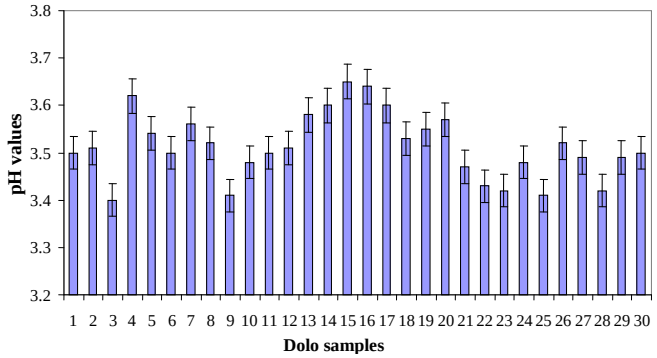

Figure 2. pH values of dolo samples.

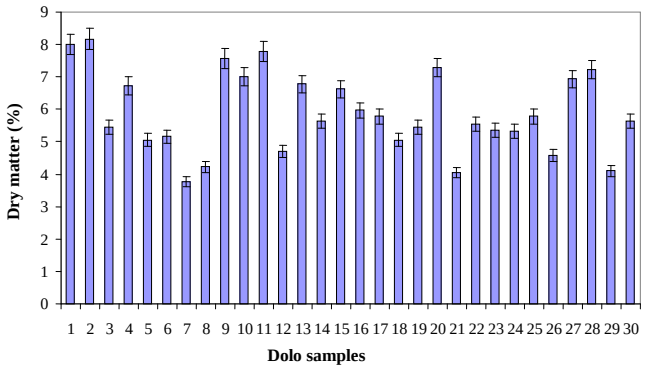

Figure 3. Dry matter content of dolo samples.

Total proteins

Total proteins were quantified by the linear method of Bradford (Zor and Selinger, 1996) using the ratio of A_{620}/A_{450} versus protein concentration. Samples were centrifuged to remove yeast cells before test.

Total carbohydrates and reducing sugars

Total carbohydrates were determined by the phenol/sulfuric method (Fox and Robyt, 1991). Reducing sugars were quantified by the oxidoreduction method using 3.5-dinitrosalycilic acid (DNS) as oxidizing reagent (Miller, 1959). Prior to each of the two assays, 1 g of dolo (equivalent to 1.1 ml of dolo) was diluted in 10 ml of 25% (v/v) of dimethylsulfoxyde in water.

Extraction of lipids

Lipids were extracted with hexane. In a separating funnel, 20 ml of dolo was added to 100 ml of hexane. The hexane fraction containing lipids was then collected and put in a rotavapor at 69°C. When all the hexane was eliminated, the flask was put in a drying oven (105°C for 30 min) then cooled in a desiccator. The flask was then weighed and the difference in weights determined the quantity of lipids (AOAC, 1990).

Statistical analysis

All the tests were done in triplicate. The data was subjected to Duncan's Multiple Test using the Statistical Package for Social Science (SPSS Inc., Illinois USA, Version 17). The degree of significance was fixed to $P = 0.05$ or $P = 0.01$ (Duncan, 1955).

RESULTS AND DISCUSSION

Results show that proximate compositions of dolo samples were variables. The variability came from the processes of red sorghums used. The variety of sorghum was shown to be *sorghum bicolor.*

pH values of dolo samples

The pH values of dolo samples manufactured in Ouagadougou ranged between 3.40±0.08 and 3.60±0.05, with an average of pH 3.50±0.07 (Figure 2). There was no significant difference in pH values among dolo samples ($P>0.05$). It clearly appeared that it is an acidic alcoholic beverage. This acid pH value is comparable with the average pH of the "bantu" beers which was between 3.5 and 4.0 (Daiber, 1975). This range of pH is similar to the average pH value of "kaffir", the filtered beer of South Africa and "amgba" the filtered beer of Cameroun, which both display an average pH value of 3.5 (Woot-Tsuen, 1970; Chevassus-Agnes et al., 1976). The pH of "tchapalo" (pH 3.01) is also acidic (Amane et al., 2005). "Tchapalo" is a traditional beer produced from cereals like corn, millet and sorghum. It is a drink whose consumption is increasing in Côte d'Ivoire. The pH of these various beers is highly acidic and permits the elimination of some microorganisms. Thus, people daily consuming these local beers are highly exposed to risk of ulcers.

Dry matter

Dry matter content of dolo samples ranged between 3.77±1.40 and 8.16±1.20% (w/v), with an average of 5.90±1.24% (w/v) (Figure 3). There was a significant variation ($P<0.01$) in dry matter content among dolo samples. Results show that levels of dry matter in dolo samples were proximate to data found in local sorghum beer "amgba" from Cameroun and lager beer (Table 1) (Chevassus-Agnes et al., 1976; Nout et al., 2003). Almost same data was found in the local sorghum beer "tchapalo" from Côte d'Ivoire (Amane et al., 2005). However, dry matter level in the local sorghum beer "bushera" from Uganda ranged between 10.28 and 12.23% (Muyanja et al., 2003). "Bushera" contained more dry matter than dolo samples. The "bushera" beer is the traditional fermented drink most commonly produced in south-west Uganda. It is mainly prepared from the grains of sorghum which can be germinated or not-germinated.

Insoluble matter

Insoluble matter content ranged between 0.12±0.02 and

Table 1. Comparison of of some beers.

Beer type	Alcohol degree (%)	pH	Dry matter (%)	Insoluble matter (%)	Total proteins (g/ 100g)	Lipids (g/100 g)	Carbohydrate (g/100 g)	Energy value (Kcal/100 ml)	Reference
Dolo beer*	2.30	3.50	5.90	0.85	0.65	0	0.77	21.8	Present study
Bock beer	2.4	-	-	-	0,3	0	4	34	Randouin et al. (1961)
Kaffir beer	2.1	3.5	-	-	0.5	0	3.6	31.1	Woot-Tsuen (1970)
Togo beer	3.03	-	-	-	0.3	0	3.34	35.8	Perisse et al. (1959)
Amgba beer	2.1	3.5	8.97	-	0.7	0.02	6.1	42.08	Chevassus-Agnes et al. (1976)
Lager beer	-	-	6	-	0.2	0	-	-	Nout et al. (2003)

*Present study; -, not determined.

1.43±0.22% (w/v) among dolo samples, with an average of 0.85±0.32% (w/v) (Figure 4). There was a significant variation (P<0.01) in insoluble matter content among dolo samples. The presence of insoluble matter is due to dust impurities in the environment where dolo is manufactured or to certain quantities of yeast remaining in the beer because of poor filtration of dolo after the fermentation step.

Alcohol content

Levels of alcohol ranged between 1.40±0.13 and 3.50±0.15% (v/v) among dolo samples, with an average of 2.30±0.25% (v/v), (Figure 5). There was a significant variation in alcohol content among dolo samples (P<0.05). The alcohol content of local sorghum beers “tchapalo”, “bock beer”, “kaffir”, “Togo beer” and “amgba” were 5.03, 2.40, 2.10, 3.03 and 2.10%, respectively (Amane et al., 2005; Randouin et al., 1961; Woot-Tsuen, 1970; Perisse et al., 1959; Chevassus-Agnes et al., 1976; Djé et al., 2008). Nevertheless, it is known that alcohol content changes during sorghum beer processing (Djé et al., 2008).

Total proteins

Total proteins concerning supernatant ranged between 11.09±0.83 and 65.01±0.67 µg/ml among dolo samples, with an average content of 26 ± 14.80 µg/ml (Figure 6). There was a significant difference (P<0.01) in protein content among dolo samples. This difference may be governed by several factors including the process of dolo manufacturers, and the difference in the characteristics of sorghum malts that are used. European lager beer, “kaffir”, “Togo beer”, “amgba” and lager beer in bottle, contained 0.3, 0.5, 0.3, 0.7 and 0.2% of total proteins, respectively (Perisse et al., 1959; Randouin et al., 1961; Woot-Tsuen, 1970; Chevassus-Agnes et al., 1976; Nout et al., 2003). The content of total proteins of dolo samples (0.65%) is slightly weaker than “amgba”. On the other hand, this content is slightly higher than other beers (Table 1). Nevertheless, dolo samples as well as other local beers and lager beers contained relatively low level of proteins.

Lipids

Lipids were not detected among dolo samples (Table 1). This is in line with previous findings, because lipids are trace constituents of beers. Indeed, similar data were found for European bock beer, “kaffir”, “Togo beer” and lager beer (Perisse et al., 1959; Randouin et al., 1961; Woot-Tsuen, 1970; Chevassus-Agnes et al., 1976; Nout et al., 2003). For instance, for 100 g of “amgba” beer, there was only 0.02 g of lipids which were quantified (Chevassus-Agnes et al., 1976). Whereas dolo samples are poor in lipids, sorghum malt may contain up to 5% of lipids (Mandjeka, 2002).

Thus, the content of lipids decreases in a significant way during fermentation. This reduction would be explained by the fact that lipids are highly hydrolyzed during fermentation to produce the energy necessary to the biochemical and physiological reactions occurring during fermentation (Somda et al., 2011).

Total carbohydrates and reducing sugars

Total carbohydrates in dolo samples significantly different (P<0.01) were ranged between 11.35 ± 0.46 and 84.10±0.49 µg/ml, with an average of 38±20.4 µg/ml (Figure 7). Reducing sugars in dolo

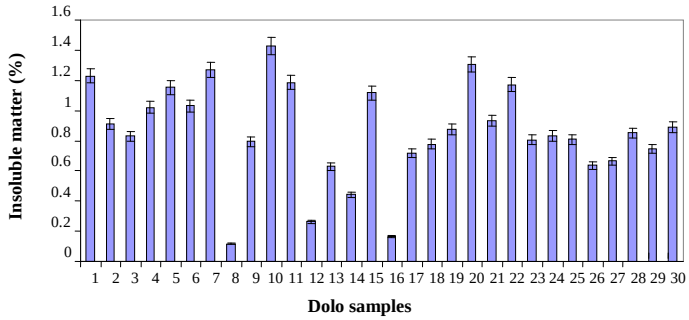

Figure 4. Insoluble matter content of dolo samples.

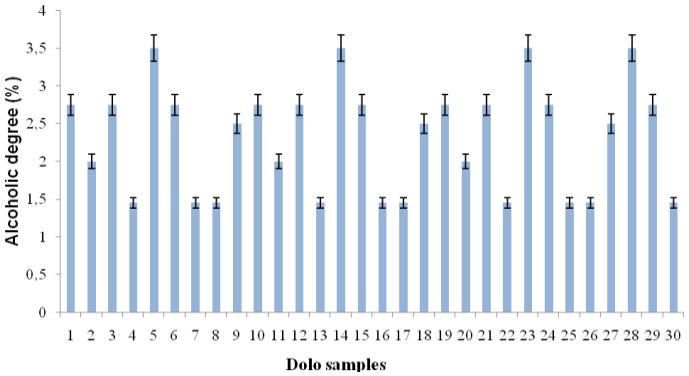

Figure 5. Alcohol content of dolo samples.

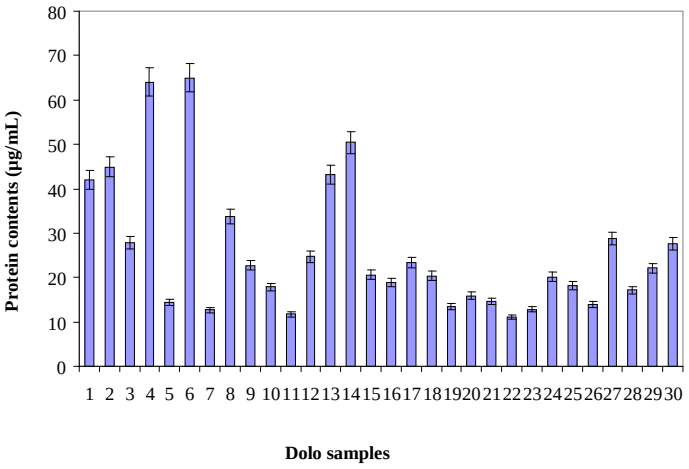

Figure 6. Total proteins content of dolo samples.

samples ranged between 4.21±0.68 and 19.94±1.50 µg/ml; were significantly different (P<0.05) with an average content of 10±3.80 µg/ml (Figure 8).

These data shows that dolo samples had different levels of both total carbohydrates and reducing sugars. Nevertheless, it appeared that dolo samples still contained significant levels of sugars, which were not metabolized during fermentation. Previous work also indicated that not

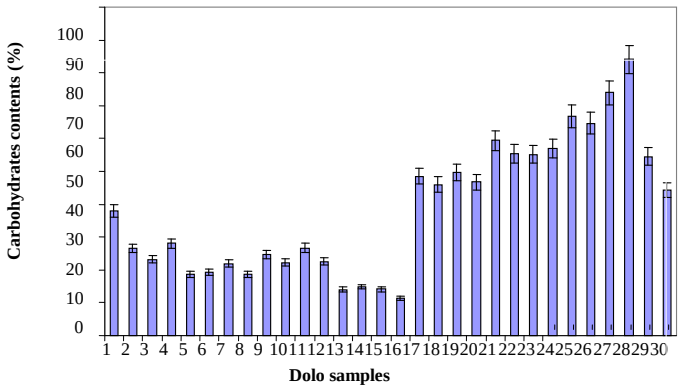

Figure 7. Carbohydrate content of dolo samples.

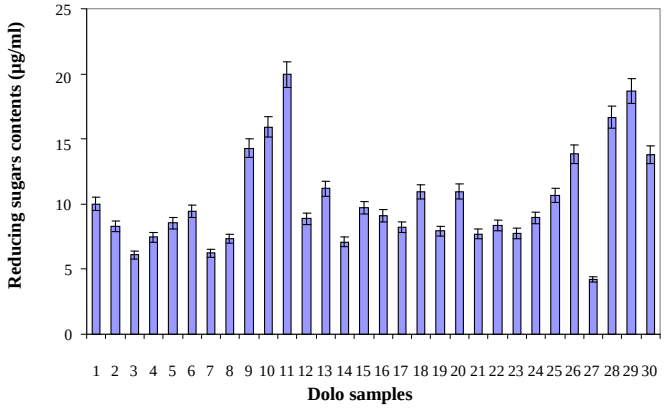

Figure 8. Reducing sugars content of dolo samples.

all sorghum sugars were consumed during the fermentation and some reducing sugars still remained in the final beer (Djé et al., 2008). Contents in total carbohydrates reported for European lager beer, “kaffir”, “Togo beer” and “amgba”, were 4, 3.6, 3.34 and 6.1% (w/w), respectively (Perisse et al., 1959; Randouin et al., 1961; Woot-Tsuen, 1970; Chevassus-Agnes et al., 1976). This data is at least four times higher than levels of carbohydrates in dolo samples (Table 1). This difference can be explained by the degree of fermentation of dolo. It is known that the more the beer is fermented, the fewer the carbohydrates that will remain. In addition, the flora of yeast used for fermentation of dolo does not have a well defined composition and its potentiality to transform sugar into alcohol varies greatly according to the micro-organisms of which it is composed. The low reducing sugar content can also result from Maillard reactions, which certainly occurred during the brewing process of dolo.

The energy value of 100 ml of dolo is about 21.8±1.6 Kcal. The corresponding values for European lager beer, “kaffir”, “Togo beer” and “amgba”, were 34 Kcal, 31.1 Kcal, 35.8 Kcal and 42.1 Kcal, respectively. Thus, the energy contribution of dolo was lower than most of other beers (Table 1).

Conclusion

There is an important variation (P<0.05) in the proximate composition of dolo samples produced in Ouagadougou. Biochemical and nutritional analysis of dolo samples may allow it to be produced in a better way with nutritional quality for the consumers and assessing the risk they are exposed as well. For instance, the acidic pH value of dolo showed that consumption of dolo may be a risk factor for ulcer. Gathered data allowed comparing the composition of local beers produced in West Africa as well as local beers and lager beers produced in the rest of the world.

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