Pozol, a popular Mexican traditional beverage made from a fermented alkaline cooked maize dough

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- Abstract -

As in numerous African countries, in Mexico maize is used to produce a great variety of traditional foodstuffs. Among them, *pozol* is a slightly acidic beverage made from a fermented maize dough, consumed in the Southeast part of Mexico. It is produced in small-scale or family sized processing units, as well as in urban or in rural areas. In order to better know *pozol* producers and consumers, and to characterise maize processing into *pozol* in an urban area, a first survey allowed to identify 62 producing units and to characterise their general characteristics. This survey was followed by a more detailed characterization made in 12 small producing units at Villahermosa (México). 79% of the producers are women of which 61% are more than 45 years old. They process between 5 and 375 kg of maize/day (median: 33kg) with a very low profit margin. The profits significantly increase (p<0.005) as production increases. From the sample of units surveyed, one producing unit out of ten is in deficit. Variable costs represent 79% of the total costs. Maize is the most expensive variable cost and it varies between 21.9 and 82.3% (mean value: 49%), mineral water represents 11.9%. Consumers belong to the low income class and 59% are male. 57% of consumers give *pozol* to their young children. However, although none give *pozol* as gruel to their young children, 80% would agree to prepare gruel from *pozol* as a complementary food.

Processing steps consist of cooking maize in lime (nixtamalization), washing, grinding, kneading the resulting dough (at this step roasted ground cocoa can be added), and fermentation (1 to 15 days). The beverage is made by blending the fermented dough with water, to which milk, horchata and sugar can be added. No major changes in the proximate composition of maize were observed during processing. The beverage has a very low dry matter content (10.1 ± 4.3 g/100gDM). Future research will focus on methods to increase the energy density of gruels prepared from *pozol* in order to meet the nutritional requirements of young children.

Key words: *Pozol* – Maize – Lactic acid fermentation – Small-scale processing units.

- Résumé -

Le *pozol*: une boisson fermentée traditionnelle mexicaine réalisée à partir d'une pâte de maïs cuit à la chaux

De nombreux procédés africains de production d'aliments fermentés à base de céréales débutent par une étape de trempage des grains, avec ou sans lavage préliminaire. Au Mexique, la transformation du maïs débute par une étape originale appelée «nixtamalization» qui consiste à cuire les grains de maïs dans une solution de chaux. Le *pozol* est un exemple typique d'une boisson traditionnelle réalisée à partir de pâte fermentée de maïs cuit à la chaux. Cette boisson était déjà consommée par les civilisations antiques méso-américaines, bien avant que les Espagnols et les Portugais n'aient découvert l'Amérique et «exporté» le maïs (et le manioc) en Afrique.

Nous présentons ici des résultats sur la transformation du maïs en *pozol* à une échelle artisanale à Villahermosa, ville de l'état de Tabasco au Sud-Est du Mexique. Cette étude avait pour objectif de mieux connaître les procédés tels qu'ils sont pratiqués en zone urbaine afin, le cas échéant, de développer des voies adaptées d'amélioration de la qualité nutritionnelle du *pozol* pour son utilisation en alimentation du jeune enfant. Des enquêtes ont été réalisées auprès de 62 unités de production pour déterminer les caractéristiques des producteurs. Douze ont été ensuite tirées au sort pour une étude plus détaillée des différentes étapes de la transformation.

La plupart des producteurs (79%) sont des femmes dont 61% ont plus de 45 ans et 71% sont mariées. 53% des producteurs travaillent avec leur famille et 10% ont des employés. 77% des producteurs vendent à la fois la pâte fermentée et la boisson directement aux consommateurs qui ont pour 61% d'entre eux entre 25 et 50 ans. Parmi les acheteurs qui donnent du *pozol* à leurs jeunes enfants (57%), 60% le font quotidiennement. Toutefois, la contribution du *pozol* à l'ingéré énergétique de ces enfants reste à déterminer. En ce qui concerne la transformation, tous les producteurs utilisent du «maïs blanc» acheté pour 61% d'entre eux au marché officiel. La quantité initiale de maïs utilisée peut varier de 5 à 375 kg/jour (médiane: 33 kg). Les principales étapes sont: la cuisson en présence de chaux (1h55), le lavage (29 min, pendant cette opération le péricarpe est éliminé), le broyage (1h45), le pétrissage (1h08, de la poudre de cacao grillé peut être ajoutée). Une pâte est ensuite obtenue et mise à fermenter de 1 à 15 jours, selon les préférences du consommateur. Le pH d'une pâte fermentée de 3 jours est de 4,0±0,2. Pour préparer la boisson, la pâte fermentée est mélangée avec de l'eau seule dans 70% des cas, ou mélangée avec du lait, de l'orgeat et du sucre.

En dépit de la combinaison de la «nixtamalisation» avec la fermentation lactique naturelle, les bouillies préparées à partir du *pozol* ne présentent pas les caractéristiques requises pour couvrir les besoins énergétiques des jeunes enfants. Des études sont en cours pour déterminer des méthodes permettant d'augmenter la densité énergétique de telles bouillies.

Mots-clés: Fermentation lactique – *Pozol* – Maïs.

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INTRODUCTION

In Africa, cereals (sorghum, millet, maize) are used to produce numerous fermented foodstuffs such as *ogi* in Benin, Nigeria, Ghana, *mahewu* in South Africa, *uji* in Eastern Africa*, kenkey* in Ghana, *poto-poto* in The Congo, etc. Among the cereals used, maize is an important staple crop. It originated in Mexico. However, Mexican maize based fermented foodstuffs are less known around the world. In Mexico, more than 605 ways to prepare maize-based foods are known, including a great diversity of alcoholic beverages and lactic acid fermented foods which are still prepared in small-scale and family sized processing units, mainly in rural areas.

Many African manufacturing procedures of cereal-based fermented foods start with soaking of the grains (with or without a preliminary washing). In Mexico, maize processing starts with an original step called « nixtamalization », which consists of cooking maize kernels in a lime solution. For example, *pozol* is a typical traditional beverage made from a fermented alkaline cooked maize dough which is suspended in water[1,2]. This acidic beverage was consumed by ancient Mesoamerican civilizations much before the Spanish and Portuguese discovered America and "exported" maize (and cassava) to Africa. Since this time until now, it is used for different purposes as food or refreshing beverage, for religious ceremonies and for its curative properties.

At the present time, *pozol* is consumed in rural and urban areas of South-East Mexico. It is produced at family and cottage level and its traditional processing shares some similarities with that of numerous traditional fermented foods and beverages in Africa. Different methods of processing have been described[2] depending on whether it is produced by rural (*pozol indigena*) or urban communities (*pozol mestizo*). The microbiology of *pozol* has been the subject of different studies, which show the importance and diversity of lactic acid bacteria[3,4,5]. It is believed that nixtamalization plays an important role in affecting the microbial community by decreasing the initial concentration of readily available mono- and disaccharides. Recent results show that amylolytic streptococci and enterococci could have a great influence on structuring the *pozol* microbial community[6]. In contrast, most amylolytic lactic acid bacteria which have been so far isolated from African cereal-based fermented foods belong to the species *Lactobacillus plantarum* and *Lactobacillus fermentum*[7, 8].

In the present work, results on maize processing into *pozol* in cottage producing units at Villahermosa, a city of the state of Tabasco (Southeast Mexico), are presented. The aim of this study was to better know the producers and consumers and to describe this processing as practiced in an urban area, in order to further develop adapted and simple techniques to improve the nutritional quality of *pozol* for infant and young children feeding. Also, taking into account its widespread consumption, *pozol* can also be an interesting support for the implementation of fortification strategies.

MATERIAL AND METHODS

An exhaustive inventory of producers was performed in five districts of Villahermosa (Tabasco, Mexico) which were clustered into three areas: AREA 1 (1 district) corresponds to the historical centre of the city; AREA 2 (2 districts) corresponds to an old part of the city (around 200 years old) that resulted from the merging of 2 small villages with the city; AREA 3 (2 districts) corresponds to a more recent part of the city (around 30 years old). The inventory identified 62 producing units. All these producing units were surveyed to determine the general characteristics of producers, and producing units. After this study, from the initial sample of 62 units, 12 were omitted since it appeared that only part of their production was made in Villahermosa.

The detailed characterization of the different steps of the processing and the economical studies were performed in 12 small producing units at Villahermosa randomly selected among the remaining 50 units identified in 5 representative districts of the city. For that purpose, a stratification of the producing units was performed according to the amount of maize processed per day and the duration of the processing.

The survey on consumers was done at the level of the retail outlets belonging to the same 12 producers which were randomly selected as indicated above. One consumer was interviewed every 15 min (starting after the first consumer of the day) during one selling day for each retail outlet. Data resulting from surveys were processed using the software Epi Info 6.04d.

Proximate composition of maize and *pozol* samples was determined on a composite sample resulting from samples collected in the 12 randomly selected producing units. The following analyses were made according to official methods (AOAC): crude protein by the Kjeldahl method (Nx6.25), crude lipids by the Soxhlet method, fibres by the Van Soest method[9] (ADF). Carbohydrate content was estimated by difference. The energy density was calculated by applying the following coefficients: 16.7 kJ (4 kcal)/g of proteins or carbohydrates, 37.6 (9 kcal)/g of lipids.

RESULTS

Characteristics of the producers

A general survey was performed on the 62 producing units identified in the 3 areas investigated in Villahermosa. It is interesting to note that similarly to situations in Africa, *pozol* production relies on women and is performed at a small scale. Most of the producers (79%) are women, 61% of which are more than 45 years old and 71% are married. 95% of producers are natives of the state of Tabasco and the remaining 5% are from the neighbour state Chiapas. 53% of the producers work only with their families, and 10% with employees. 77% of producers are retailers and sell both the fermented dough and the beverage. 90% of producers consume also the *pozol* they produce, but the self-consumption is minor since it represents only 1/4 of the production for 2% of those producers which process no more than 10 kg of maize.

As for the know-how of producers, 54% of them acquired it recently (less than 5 years ago). For 74% of producers, the know-how was passed down by a direct ascendant (another similarity with African producers), 14% learnt to produce *pozol* by themselves by observation of others, and 12% learnt it from another member of the family or a friend.

Cost-effectiveness of the producing units

The survey of 12 representative producing units indicated that variable costs represent 79% of total charges. Purchase of maize represents the most important variable cost which varies between 21.9 and 82.3% (mean value: 49%), the second important expense is cocoa (13.3%, Min: 2.7%, Max: 24.1%) when it is used and mineral water (11.9%, Min: 3.4%, Max: 22.3%). Fixed costs are lower than 6% for processing units which do not have employees. Depreciation costs are very variable: depending on the presence or not of employees, they may vary from 3.1 to 100% of fixed costs (mean value: 32.5%). As for profits, there is only a very small difference between the gross profit margin and the net margin. The net margin for producers is very low and one producing unit out of 10 was in deficit. The difference in the amount of maize which is processed explains the variability in the observed margins between producers. There

is a significant relation ($p<0.005$) between the level of production and margins: the profit margins increase with increasing production.

Characteristics of the consumers

The survey of 118 consumers interviewed at 12 retail outlets indicated that *pozol* is mainly consumed by the middle-class and the poor, which is another common characteristic with African consumers of fermented cereal-based foods. *Pozol* is consumed daily by 56% of the consumers. 37% of consumers are unemployed and among those who have a job, 86% have a low income. The majority of consumers are male (59%). 61% of the consumers are aged between 25 and 50 years. Most of the consumers (80%) have children. Among those who gave *pozol* to their young children (57%), 60% did it on a daily basis. The contribution of *pozol* to the energy intake of young children has to be estimated yet. Young children consume *pozol* as a beverage, but never as a gruel in contrast to children in many African countries where fermented cereals are used as complementary foods. However, 80% of Mexican consumers surveyed in the city of Villahermosa would agree to feed their young children with gruels prepared from *pozol*, because they believe that *pozol* is “nutritious and contains a lot of vitamins”. The remaining 20% did not agree at all for unexplained fear. Such results support the idea that a new complementary food made from *pozol* and consumable as gruel could be developed.

Characterization of the processing

A detailed characterization of the processing of maize into *pozol* was made in the 12 representative producing units randomly selected and allowed to establish the diagram shown in figure 1. All producers use “white maize” and 61% of them bought it at the official market. The initial amount of maize used can vary from 5 kg to 375 kg/day (median: 33 kg). The average total duration of processing (including roasting and grinding cocoa) is 7h27, but it can vary between 1h36 and 18h05 according to the amount of maize to be processed. The main steps consist of: cooking in lime (mean: 1h 55, Min: 1h00, Max: 2h45), washing (29 min, Min: 10 min, Max: 1h00; during this operation the pericarp is eliminated), grinding (1h 45, Min: 15 min, Max: 8h00), kneading (1h08, Min: 10 min, Max: 6h00; at this level roasted ground cocoa can be added). A dough is then obtained, which is further fermented between 1 to 15 days, according to the preferences of the consumers. The pH value of a 3-day fermented dough is 4.0 ± 0.2. To prepare the beverage, the fermented dough is blended with water alone (70% of the cases) or milk, *horchata* (a beverage made of raw soaked rice) and/or sugar are added according to consumer preference.

No major changes in the composition of maize were observed throughout the processing (table 1), except a slight increase of crude lipids content in the 3-day fermented dough. Adding cocoa increased crude lipids and fibre contents and decreased the carbohydrate content, but without consequences on energy content of the beverage on a dry matter basis. However, the dry matter content of the beverage is low (10.1 ± 4.3 g/100gDM) and when gruels are prepared from *pozol*, their consistency is similar to that of gruels prepared from maize flour without adding a source of amylase (not shown).

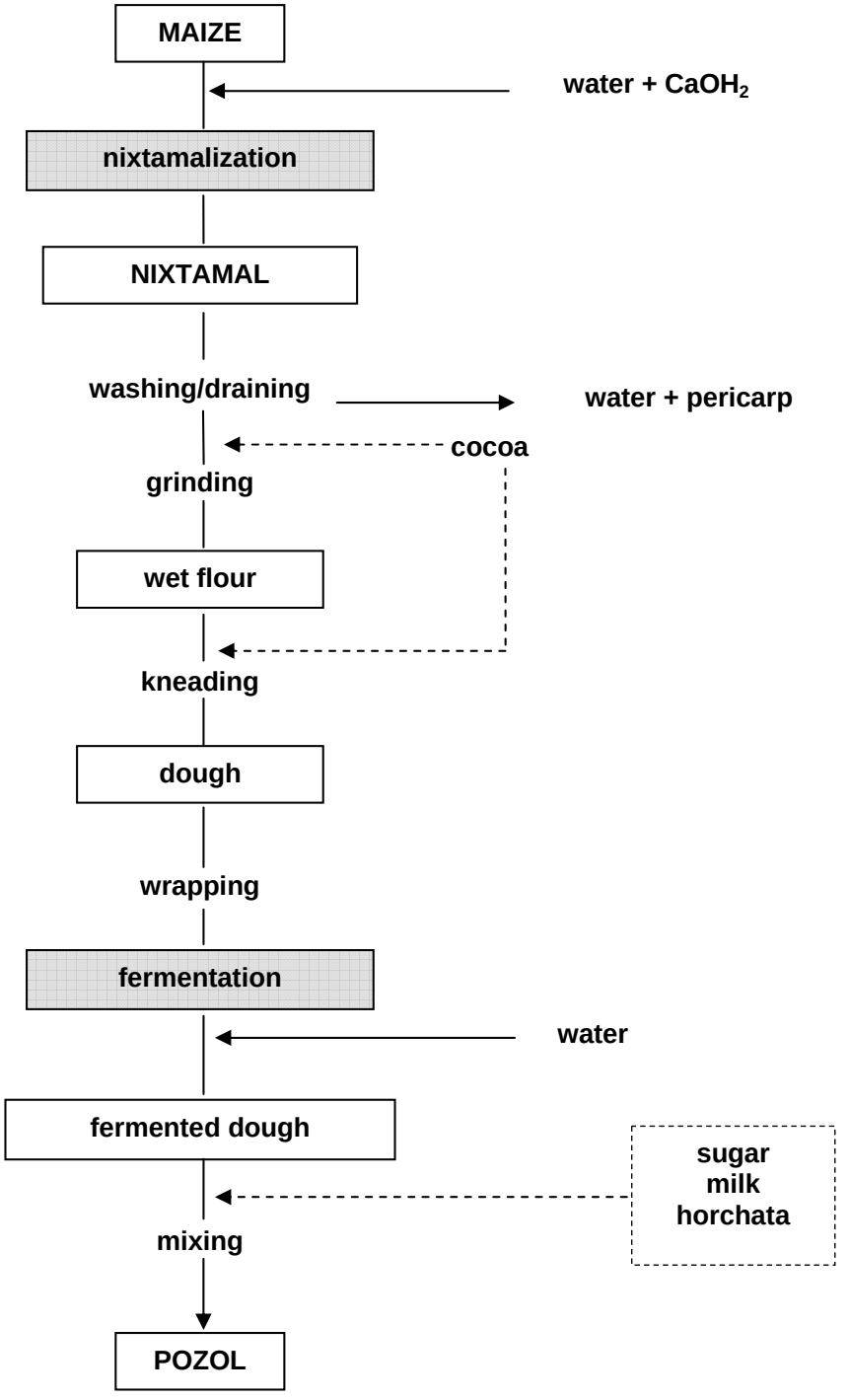

Figure 1: Processing of maize into *pozol (dotted lines are for facultative operations).*

Table 1: Changes of proximate composition (g/100 g dry matter) of maize during its processing into *pozol* (data obtained from average samples taken in 12 representative units).

	Crude Protein	Crude Lipids	Fibres	Ash	Total Sugars	Energy (kJ/100gDM)
Maize (grains)	10.2	4.5	3.7	1.4	80.4	1680
Nixtamal	9.8	4.7	4.3	1.2	80.0	1676
Dough	10.0	5.6	4.0	1.4	79.0	1697
fermented dough *(3 days)*	10.2	5.5	3.7	1.4	79.3	1701
fermented dough with cocoa *(3 days)*	10.6	9.2	9.8	1.5	68.8	1672

CONCLUSION

This preliminary investigation indicates that *pozol* produced in an urban area is consumed by the low income class and by young children. However, to develop a complementary food which meets the nutritional requirements of young children, more detailed studies are required to determine ways to increase the energy density of *pozol*-based gruels and to quantify changes of micronutrients (e.g. vitamins and minerals) and of antinutritional factors (e.g. phytates) during processing.

It is interesting to observe that in spite of the nixtamalization step (during which most microorganisms die), a natural lactic acid fermentation takes place. According to Wacher[2], inoculation with lactic acid bacteria can occur during the grinding of cooked maize. Such information is interesting in the sense that processing of cereals to elaborate fermented foods in Africa involves a grinding step and contribution of this step to the microbial diversity of these foods still needs to be evaluated.

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