Indigenous processing methods and raw materials of *borde*, an Ethiopian traditional fermented beverage

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Abstract

A study of village-level processing techniques and raw materials used for the production of *borde* was carried out using open-ended questionnaires and on the spot interviews with producers at six localities in southern Ethiopia. The major focus of the study was on indigenous processing methods, types and proportions of ingredients, sources of energy, shelf life, sensory properties and the importance of *borde* for household food security. From results of the study, *borde* was characterized as an opaque, effervescent, whitish-grey to brown coloured beverage with a thick consistency and sweet-sour taste. It may be prepared from grits/flour of unmalted maize, barley, wheat, sorghum and/or finger millet and their malts using locally available earthenware and metal equipment. The type of unmalted cereal ingredients and amount of malt used for *borde* preparation varied within and between localities and were selected according to availability, price and preferences. A flow chart of *borde* production was constructed showing four major processing stages. The short shelf life of *borde* and the seasonal variations in production volume were identified as major problems for the vendors in the study areas.

***Keywords*: indigenous methods; cereal fermentation; *borde*; beverage; Ethiopia**

Introduction

Fermentation is a widely practiced ancient technology and fermented foods are an essential part of diets in all regions of the world. Traditional fermented beverages are those that are indigenous to a particular area and have been developed by the local people using age-old techniques and locally available raw materials. Early man probably used short time fermented beverages as a safe substitute for water, since the alcohol content is too low in the early stages of fermentation to produce intoxication (Rose, 1977). Traditional recipes are handed down through generations and are still used for food processing in many developing countries. However, developing countries cannot continue to depend on historical methods of food processing. Traditional fermentation processes and the potential for their modernization are increasingly attracting the attention of scientists and policy makers as a vital part of food security strategies (van de Sande, 1997) and commercial use.

Some information is available on the microbiology and biochemical properties of a variety of African traditional fermented beverages such as Ethiopian *tella* and *borde* (Sahle and Gashe, 1991; Ashenafi and Mehari, 1995), Nigerian *pito* and *burukut* (Iwuoha and Eke, 1996), Zambian *munkoyo* (Zulu *et al.*, 1997), Southern African *bantu* or sorghum beer (Novellie, 1959), Zimbabwean *chibuku* and *mahewu* (Gadaga *et al.*, 1999), Sudanese *merissa* and *hulu-mur* (Dirar, 1993; Mahgoub *et al.*, 1999), Kenyan *bussa* (Nout, 1980), Egyptian *bouza* (Morcos, 1977), Ugandan *bushera* (Muyanja, 2001) and Tanzanian *togwa* and *mbege* (Kingamkono *et al.*, 1998; Shayo *et al.*, 1998; Mugula, 2001). These traditional African beverages are also considered by the consumers to be a type of food (Platt, 1955; Aucamp *et al.*, 1961).

In Ethiopia, villagers prepare a wide range of traditional fermented foods and beverages from different raw materials such as cereals, *ensete* (false banana), honey, milk, etc. Some of the known Ethiopian traditional fermented foods and beverages are *injera*, *dabo*, *ambasha*, *kocho*, *bulla*, *ergo*, *siljo*, *tella*, *teji*, *areki*, *borde*, *cheka*, *shamita*, *korefe*, *keribo*, *bukire*, *kineto* and *merissa*. These products, if properly exploited, could be of significant economic importance for the country. Most of the customs and rituals involving the Ethiopian traditional fermented foods and beverages are still prevailing today in urban areas, village communities and rural households. These foods are relatively cheap to prepare and are therefore important alternatives for low-income consumers who cannot afford imported or industrially processed foods and beverages. However, a more effective and rational production could give increased income for those who are involved in the production.

Borde is a cereal-based traditional fermented beverage and is widely consumed in the southern and western parts of Ethiopia. It is produced by spontaneous fermentation using rudimentary equipment. *Borde* is an opaque, effervescent, whitish-grey to brown coloured beverage, with a thick consistency and a sweet-sour taste. It is an important product because both adults and children often consume it as a low-cost meal replacement.

Only limited microbial and chemical information is available on *borde* in southern (Ashenafi and Mehari, 1995) and central (Bacha, 1997) Ethiopia. However, further studies are needed to document the existing technology, identify constraints and optimise the processing conditions and raw materials of *borde* production, to achieve good and stable product quality. In this paper, the raw materials and indigenous processing techniques used in the production of *borde* in southern Ethiopia are described.

Materials and Methods

A survey of indigenous processing methods and raw materials used for the preparation of *borde* was carried out using open-ended questionnaires and on the spot interviews with 106 *borde* brewers at six localities in southern Ethiopia, namely Areka, Awassa, Bedessa, Boditi, Gununo and Sodo Zuria. The brewers were interviewed in their native language in the village or at the market place of each locality. In addition, four households in Awassa were visited in order to observe the process and also record the pH and cooking temperatures during the production of *borde*. The questionnaire had five categories: 1) indigenous processing techniques and types of equipment, 2) types and proportions of ingredients, 3) sources of energy, 4) economic importance and 5) sensory properties and shelf life of *borde*. In addition, the respondents were asked to explain major problems in production, distribution and consumption of *borde* and to suggest possible solutions, if any. The data from the survey were translated and analysed with respect to locality.

Results

Ingredients of *borde*

Borde is prepared from unmalted maize (*Zea mays*), barley (*Hordeum vulgare*), wheat (*Triticum sativum*), finger millet (*Eleusine coracana*), sorghum (*Sorghum bicolor*) and/or *tef* (*Eragrostis tef*) and their malt, except sorghum and *tef* (**Table 1**). *Tef* is less often used for *borde* preparation, probably due to its high price and preference for use in *injera* (a pancake-like bread). The type of cereal and amount of malt utilized for *borde* production varied both within and between localities. Maize, followed by barley and wheat, was found to be the most common ingredient of *borde* both as malt and unmalted ingredient in southern Ethiopia, whereas wheat has been reported to be the preferred unmalted ingredient in Addis Ababa (Bacha, 1997). Some brewers in Awassa and at Bedessa used both finger millet and sorghum as unmalted ingredients unlike Areka and Boditi, whereas some at Gununo and Sodo Zuria used sorghum but not finger millet. Sorghum was utilized as unmalted ingredient but not as malt in the study areas. Finger millet was more frequently utilized for malt preparation than as unmalted ingredient. The ingredients used and their possible combinations were found to vary within and between households regardless of localities and are selected according to availability, price and preference. Seasonal variations in the price of the various cereals affect the choice of ingredients. During this study, variation in the market price (Ethiopian Birr/*kg*) of *tef* (2.6-2.8), wheat (2.2-2.4), finger millet (1.7-2.0), sorghum (1.5-1.7), barley (0.95-1.1) and maize (0.80-0.95) was observed. Maize is commonly cultivated and more available in the study areas. Thus, maize is more frequently used than other cereals for *borde* fermentation due to its low price.

The unmalted ingredients and malt flour could either be exclusively from one type of cereal or from a mixture of different cereals. *Borde* brewers preferred to use a mixture of malt rather than single-cereal malt and approximately equal proportions were used. The amount of malt added in *borde* preparation varied widely between households regardless of the locality, type or quantity of unmalted ingredients, and types or combinations of malt. The amount of malt used was found to vary between 15 and 40% (w/w) of the maize grits used for the primary fermentation at Phase I (section 3.4.1) irrespective of the type of cereal used for malt.

Table 1. Utilization of various cereals for *borde* production in each study area

Mode of ingredient	Study areas	Number of respondents utilizing each type of cereal (n=20*)				
		Maize	Barley	Wheat	Finger millet	Sorghum
Unmalted	Areka	20	8	6	0	0
	Awassa**	6	4	4	2	2
	Bedessa	20	3	6	4	5
	Boditi	20	18	3	0	0
	Gununo**	20	11	6	0	3
	Sodo Zuria	20	7	2	0	2
	Total	**106**	**51**	**27**	**6**	**12**
Malted	Areka	20	20	14	3	0
	Awassa	6	6	6	6	0
	Bedessa	20	7	9	13	0
	Boditi	20	20	12	7	0
	Gununo	20	20	16	5	0
	Sodo Zuria	20	20	16	8	0
	Total	**106**	**93**	**73**	**42**	**0**

* n= 6 for Awassa; **, 2 brewers in Awassa and 1 at Gununo used unmalted tef

Preparation of malt

The traditional technique used for the preparation of malt (*bikil*) was similar in all localities and different cereals were always prepared separately. The grains are first cleaned of all chaff, broken kernels and extraneous materials, rinsed repeatedly and then soaked in clean water for one day at ambient temperature (20-23 °C). After draining excess water, the grains are wrapped in portions of 1-2 kg in false banana (*Ensete ventricosum*) or other large leaves and kept moist. The germination takes 2 days for finger millet or 3 days for other cereals. After removal of non-germinated grains, germination is halted by sun drying. Each type of cereal malt is stored separately in a dry place until required. A portion of dry malt is then milled into flour for immediate use. The malt flour may be utilized individually or as a mixture. In some instances, fresh malt is wet milled and used.

Table 2. The types of traditional operation and equipment used for *borde* production

Types of operation	Types of equipment
Drying of grains	Sacks, mats, plastic sheets, trays & ensete leaves
Cleaning (removal of impurities)	*Sefedi* (a circular flat tray made of special grass fibre)
Dry milling of ingredients	*Wofcho* (grinding stones) or hammer mill
Fermentation of maize grits	*Insira* (earthenware pot) or bowl
Roasting of sour mass into *enkuro*	*Mitad* (griddle made of clay or a thick iron sheet)
Fermentation of *enkuro* with malt	*Insira* or *gan* (earthenware pots)
Steam cooking of *gafuma*	*Insira* containing wooden rods (5-8 cm diameter)
Boiling of thick porridge	*Insira* or *dist* (clay saucepan)
Cooling of cooked ingredients	Clay and/or metal griddle, bowl, tray and mats
Sieving of the fermenting mash	*Wonfit* (a conical basket made from grass fibre with interwoven grass-thread mesh at the bottom)
Wet milling of the residue	*Wefcho* (grinding stones)
Fermentation of the pooled filtrate	*Insira* or *gan*
Storage & distribution of *horde*	*Insira*
Serving utensils	Gourd bottles

Equipment and source of energy

Traditional brewers used locally available equipment such as earthenware (pots, plates, bowls), grinding stones, baskets and sieves made from *geta*, a type of grass and gourd bottles (**Table 2**). Traditionally, cereals were milled using grinding stones and these are still used for malt and wet milling. Today, however, flour mills are available in several villages. *Mitad*, a griddle of iron or clay, is used for roasting. Varying size of *insira*, a clay pot, is used for steam cooking of ingredients and transporting of *borde* to the market. For fermentation, bulbous earthenware pots with a narrowed neck, *insira* or *gan*, are used exclusively. The capacities of *insira* and *gan* for *borde* production are 30-40 and 60-90 L, respectively. *Wonfit*, a conical basket made from grass fibre (*geta*) with an interwoven grass-thread mesh at the bottom, is used to sieve the mash. It is also customary to use gourd bottles for serving *borde* and interestingly their shape (narrow neck) and capacities (400 ml) are similar throughout the study area. The brewers are reluctant to use other kinds of equipment for *borde* production. *Borde* preparation includes several heating stages. In the order of importance, firewood, dried cow dung and crop residues are used as fuel.

Steps in *borde* production

As shown in the flow chart (**Fig. 1**), the production of *borde* has four major phases, which are marked by the introduction of fresh ingredients into the fermentation vessel. The phases were found to be similar in all the six study areas and are described in the following sections.

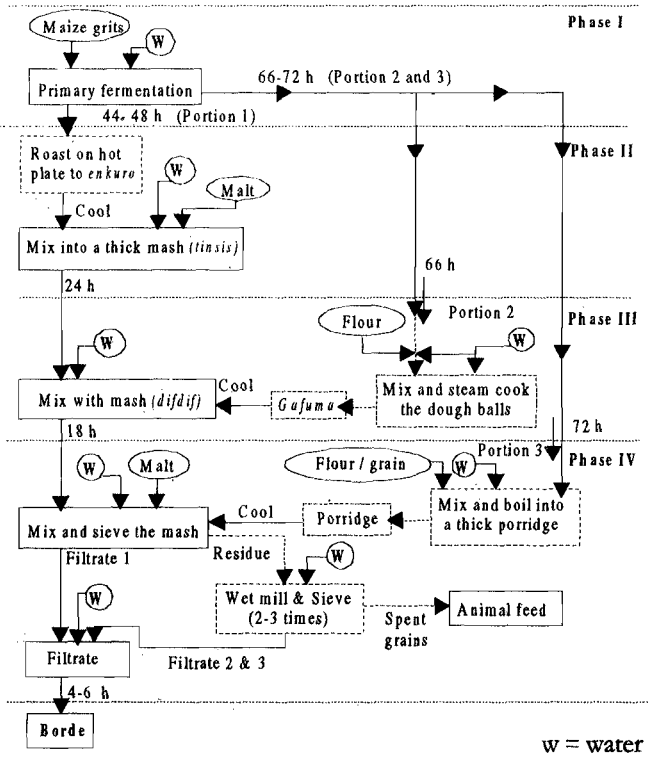

Figure 1. Flow charts: traditional preparation of *borde* in southern Ethiopia

Phase I

In Phase I, the primary fermentation, maize grits are mixed with water enough to immerse them in a clean *insira* and allowed to ferment for 44 to 72 h. The content is apportioned into three parts at different periods (44-48 and 66-72 h), cooked with other non-fermented ingredients and used at Phase II, III and IV of main fermentation.

Phase II

Phase II is the beginning of main fermentation of *borde* from malt flour and roasted unmalted main ingredients. The main fermentation *gan* or *insira* is prepared by cleaning with *grawa* (*Vernonia amygdalina*) leaves and is then smoked with glowing splinters of *weira* (*Olea africana*) wood. A portion of 44-48 h fermented mass from Phase I is roasted on a hot *mitad* into *enkuro*, a well-roasted granular mass, at about 90°C for 30-45 min. The cooled *enkuro* and fresh malt flour are blended with water in a cleaned and smoked *insira* or *gan* to a light brown thick mash. The brewers mix the ingredients using their hands and adjust the consistency of the mash. This mixture is called *tinsis* and allowed to ferment for about 24 h. The ingredients added at Phase II are about 25% of the total unmalted ingredients and 75% of the total malt required on dry weight basis in the whole *borde* preparation.

Phase III

During preparation of unmalted ingredients for the third phase, a second portion of the fermented mass (now about 66 h old) from Phase I is slightly roasted, cooled, thoroughly kneaded with more flour and water and then moulded into dough balls. Another clean *insira* for steam cooking is prepared, with some water at the bottom and a bed of short wooden rods covered with false banana leaves. The dough balls are placed on the leaves in the *insira*, which is then covered tightly with a lid and compact fabrics. They are then steam-cooked for 1-1.5 h into *gafuma*. When the water is

exhausted, more is added through a hole made using a straight stick through the tightly packed dough balls. It is considered important that the water is not poured over the dough balls themselves. *Gafuma* is the generic name of steam cooked dough balls, which have a pleasant aroma of fresh bread. The *gafuma* is broken into pieces, cooled and blended with the fermented *tinsis* and water to a thick brown mash called *difdif*. The *difdif* is then allowed to ferment for 18 h. The ingredients added to the fermented *tinsis* at Phase III are about 50% of the total unmalted ingredients required on dry weight basis in the whole *borde* preparation.

Phase IV

The last portion of fermented mass (about 72 h) from Phase I is mixed with a boiling porridge prepared from flour or grain. The content is maintained with continuous stirring at about 90°C for 1-1.5 h into a very thick porridge. The cooled thick porridge is blended with the fermented *difdif*, along with some additional malt and water. This mixture is then sieved using a *wonfit* (about 1 mm pore size). The residue is wet-milled using grinding stones and then sieved again by slurrying with more water. The wet-milling and -sieving operations are repeated up to 3 times. All the three fractions of filtrate are collected together, poured back into the rinsed main fermentation vessel and the consistency adjusted if necessary. This filtrate is allowed to ferment for a further 4-6 h. The actively fermenting, effervescent *borde* is then ready for consumption. It was observed that a substantial amount of waste ingredients (15-20% of the total yield) is used as animal feed. The ingredients added at Phase IV are about 25% of the total unmalted ingredients and 25% of the malt required on dry weight basis in the whole *borde* preparation.

The production of a batch of *borde*, as described above, takes about four days. All unmalted cereal ingredients are cooked and subsequently cooled (23-26°C) before introducing them into the main fermentation vessel. In contrast to Phase I, once the heat-treated and cooled unmalted ingredients are mixed with malt, the fermenting mash is not heated throughout the entire process of production. Thus, the second, third and fourth phases of *borde* fermentation (**Fig. 1**) occur in the same vessel. The colour of the cereals used and the extent of heat-treatments that *enkuro*, *gafuma* and porridge receive have a direct effect on the colour of *borde*. The brewer controls these parameters and thereby determines the colour of the end product. *Borde* fermentation takes place at ambient temperature (20-23 °C). However, during cold weather the fermentation vessel is covered with clothes or sacks and put near the fireplace to maintain the desired temperature. The production of *borde* is a laborious and complex technology and is exclusively carried out by women.

Shelf life and patterns of consumption

Borde is produced for income generation, household consumption or special occasions. *Borde* is considered to be ready for consumption after the last phase of the fermentation and when it is still vigorously bubbling. *Borde* is retailed at market places, at the side of busy roads or at vendors' house. According to the consumers and brewers, the most important sensory properties of a good quality *borde* are described as showing active effervescence and having a refreshing aroma, uniform turbidity, thick consistency, sweet-sour taste and a fairly smooth texture. When the active fermentation slows down, this is a signal of quality deterioration and after a while the product becomes sour and alcoholic. *Borde* has a problem of short shelf life. It should preferably be consumed within 3-5 hours and it becomes unfit for consumption after 12 h. The vendors prefer to use several small fermentation vessels, an *insira* rather than larger *gan*, in order to synchronize their supply to a whole day's marketing and thus to avoid loss. This happens by varying the adding time of *gafuma* and porridge into *insira*.

Borde is produced on a small-scale basis and is consumed locally. Consumers considered *borde* as a non- or low-alcoholic beverage. It is consumed by both adults and children as a drink and low-cost meal at any time of the day. It is consumed daily, especially during the dry season. An average worker consumes about 3 to 5 gourd bottles (1 to 2 litre) of *borde* per day, which would sustain her/him without additional food for most of the day. It is consumed in large quantities at cultural festivals, on market days and at collective work gatherings. The popularity of *borde* among the population in the region indicates its production in very large volume. High price and poor availability of raw materials and cooking fuel during the food-deficient rainy season, July to September, result in a reduction or cessation of *borde* production for some vendors. However, some brewers prepare *borde* using wet milled green maize ingredient and malt flour when raw materials are scarce.

Borde is also used for medical and ritual purposes. Consumers believe that *borde* enhances lactation and mothers are encouraged to drink substantial amounts of it after giving birth. *Borde* is also considered to alleviate malaria, diarrhoea, constipation and abscesses. Garlic, fresh chili (*Capsicum minimum*), ginger and salt are offered as appetizing accompaniments to reduce the feeling of fullness and encourage the intake, which may also contribute to some medical effects, if any. Mothers recommend feeding children with *gafuma* and blended *borde*. They believe that *gafuma* sustains the child for most of the day without additional food and also makes him strong and healthy. However, the dietary bulk and energy density of *gafuma* has not been investigated.

Discussion

Borde is a multipurpose product, which is socio-culturally bound especially with the southern and western Ethiopian people. *Borde* is often a low-cost meal replacement for many poor people in the country. Bacha (1997) reported 21.8% dry matter in *borde*. However, the preparation of *borde* is time consuming, tedious and complex. The traditional recipe for *borde* fermentation seems to be a very important way for the indigenous people to utilize a wide variety of cereal crops. The cereal ingredients used vary from place to place in the communities that prepare (and consume) *borde*. Although it appears that each housewife has her own preference of ingredients, the overall technology of traditional *borde* preparation was found

to be similar in all the study areas. The consumers' preference for *borde* from blended cereals might be due to the organoleptic properties of the resulting product. According to Steinkraus (1996), fermentation can enrich food substrates biologically with protein, essential amino acids, essential fatty acids and vitamins; enhance the diet through a diversity of flavours, aromas and textures; and decrease cooking time and fuel requirements. Thus for the villagers, fermentation of *borde* could be considered as an economical means of utilizing a variety of cereal crops to produce a product with improved palatability and nutritional value. It would be worthwhile to investigate the optimum proportions, selection and possible combination of unmalted ingredients and/or malt among cereals for *borde* production and to evaluate its nutritional content.

In this study, it was found that *borde* preparation requires about 4 days, unlike the over-night fermentation reported by Ashenafi and Mehari (1995) in Awassa. It is possible that in that study, the vendors did not fully describe the whole process of the treatments, steps and time of introduction of ingredients into the fermentation pot.

The processes involved in *borde* production are more complex than those of similar traditional fermented beverages such as Ethiopian *shamita* (Bacha, 1997), Zimbabwean *mangisi* (Zvauya et al., 1997), South African *mahewu* (Schweigart and de Wit, 1960), Nigerian *obiolor* (Achi, 1990), Sudanese *hulu-mur* (Mahgoub *et al.*, 1999), Turkish *boza* (Hancioglu and Karapinar, 1997), Tanzanian *togwa* (Lorri, 1993; Mugula, 2001), Ugandan *bushera* (Muyanja, 2001) Egyptian *bouza* (Morcos, 1977) and Zambian *munkoyo* (Lovelace, 1977). Traditional *borde* brewers rely upon rudimentary equipment and sources of energy, which do not readily lend themselves to modernization of the process or development of local capabilities. Firewood, cow dung and crop residues are traditionally used for cooking of the ingredients and alternative energy sources should be sought when the production technology is upgraded. Modernization of traditional fermented products necessitates understanding of the character of the fermentation and a refinement of the process (BOSTID, 1992), which also applies to *borde*. In this way, it may be possible to alleviate the problems of the tedious, time consuming and complex processing techniques and also to improve *borde* production and its keeping quality.

Cooking of the ingredients would gelatinise the starch and make it more easily available for the amylases in the malt that facilitate saccharification. This in turn would create a more conducive environment for microbial growth during *borde* fermentation. Several researchers (Akinrele, 1970; Nout, 1980; Adegoke and Babalola, 1988; Johansson *et al.*, 1995; Damelin *et al.*, 1995; Bacha, 1997) have indicated that the microorganisms involved in the natural fermentation of cereals are essentially the microflora of the raw materials and equipment. *Borde* brewers also believe that the fermentation pot, *insira/gan*, is not satisfactory for fermentation until it has been used several times. This is an indication that microorganisms are retained in the *insira/gan* (Sahle and Gashe, 1991; Bacha, 1997) from the previous batch of fermentation. Back-slopping was not reported in the current study areas. Thus, spontaneous fermentation of *borde* could be initiated by a variety of microorganisms from the malt, fermentation vessel, blending water, brewing personnel, milling and mixing utensils. Microorganisms from the malt and the fermentation vessel are probably more important due to their adaptation to the raw material of *borde*. *Borde* brewers prefer to use malt from more than one type of cereal. The mixture of malt may have a wider array of endogenous enzymes that would achieve greater degradation of cereal starches. This creates a rich and complex growth medium for a variety of fastidious microorganisms initiating the spontaneous *borde* fermentation. The malt for *borde* fermentation was shown to have a wider diversity of microorganisms than a back-slopping starter, although the starter had higher microbial load (Bacha, 1997). After malt has been introduced to the fermentation pot, there is no heat-treatment that would inactivate the malt amylases or the microorganisms present in the mash. This is a critical aspect of the indigenous technology of *borde* production.

Borde is considered to be a low alcoholic beverage even though the duration of its fermentation is long enough (4 days) to result in a considerable accumulation of ethanol (Rose, 1977; Fite and Tadesse, 1991). However, the introduction of ingredients into the fermentation vessel at several times has a natural "semi-continuous" fermentation approach, which may dilute the alcohol content of *borde*. The primary fermentation at Phase I takes about 48 h. This is succeeded by roasting, steam cooking and boiling of the fermented mass from Phase I with or without unmalted fresh flour. These heat treatments would drive off some volatile compounds including ethanol produced during the Phase I fermentation. Alcohol may also be produced during Phase II and Phase III fermentation but this may be diluted by the addition of the thick porridge and water during wet-milling and sieving operations at Phase IV. Since the duration of Phase IV fermentation is short (4-6 h), a significant amount of alcohol would probably not accumulate. According to Rose (1977), the alcohol content in the early stages of fermentation of beverages is too low for an intoxicating effect. Thus, the method of production may perhaps explain why a *borde* is considered to be low alcoholic beverage by the consumers.

Conclusion

This study has documented that *borde* is produced at a small-scale level using a variety of cereals and rudimentary equipment in a complex indigenous method. It has a poor keeping quality. Apart from the merits of fermented products in general, *borde* plays an important role in cereal crop utilization and is a low-cost meal replacement for both children and adults. Understanding the biochemical changes during the use of various raw materials and processes, optimisation of processing parameters and identification and use of microorganisms isolated from the traditional product, *borde*, are therefore, indispensable priorities for upgrading to a small-scale commercial production. Investigations are currently underway to

optimise some processing parameters and identify bacterial isolates from *borde* for starter culture development.

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