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DISCOVERY OF *SAKÉ* IN CENTRAL AFRICA : MOLD-FERMENTED LIQUOR OF THE SONGOLA

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Résumé. — L'auteur a trouvé un nouveau type d'alcool de riz en République du Zaïre. Les moisissures jouent un rôle indispensable dans la saccharification de l'amidon, comme dans le cas du **saké** au Japon. Une comparaison des conditions initiales de la fermentation suggère une origine indépendante de l'Asie. D'autres études de terrain permettront probablement de révéler l'existence de telles boissons fermentées à base de moisissures dans d'autres régions d'Afrique.

Abstract. — A new type of alcoholic beverage from rice was discovered in the republic of Zaïre. Molds on rice play an indispensable role in the saccharification of starch, as is the case of Japanese **saké.** Comparison of starters for fermentation suggests its origin independent of Asia. Further field survey will probably reveal the existence of such mold-fermented alcoholic beverages in other regions of Africa.

I. — SAKÉ IN THE ALCOHOLIC BEVERAGES OF THE WORLD

What is the place of the Japanese traditional beverage *saké* in the classification of the alcoholic beverages of the world ? It is made from rice, and is different from wine. It is also quite different from beer as will be explained below. All of the traditional Japanese beverages including *saké* have a single process of fermentation in which molds play an indispensable role. The nature of fermentation of *saké* is surprizingly unknown to people living outside of Asia where *saké* and its relatives have been the most important alcoholic beverages (1).

All the alcoholic beverages of the world are generally a result of a single biochemical transformation : yeasts (species of the genera *Saccharomyces, Amylomyces, Endomycopsis,* etc.) transform sugar (glucose, fructose, or sucrose) into ethanol

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(1) *Saké* is fermented with rice without distillation. It has an alcoholic content of 15-20 %, and has transparent, pale yellow color with specific aroma, slight acid and sweetness. It is also called as *seishu* (clarified alcoholic beverage) or *nihonshu* (alcoholic beverage of Japan) for the purpose of distinction from *"saké"* in a broad sense that includes all the alcoholic beverages. I use the term *saké* in a narrow sense in this paper. ANGLADETTE (1966 : 564) and STEINKRAUS (1983 : 375) provide detailed flow charts of industrialized *saké* production.

and carbon dioxide. The major difference exists in the process prior to sugar formation. The dichotomy of distillation/non-distillation is of limited significance in spite of its importance in the domain of gastronomy (SALLÉ et SALLÉ, 1986), because we can, in theory, distill all types of alcoholic beverages.

Thus, the keys for a scientific classification of alcoholic beverages will be the difference of materials used and the ferments that change the materials into sugar (Table 1). The difference of starter for the ferments will provide us of a more elaborate classification. In this way, WERTH (1954) classified the alcoholic beverages of the world : carbohydrates or materials for fermentation are classified as, 1) sugar that is ready for alcoholic fermentation, 2) lactose that must be first transformed into sugar by galactosidase (an enzyme), or 3) starch that requires transformation into sugar by amylase (another enzyme). Amylase derives from three different ferments : 3a) saliva, 3b) malts or germinated grains, and 3c) molds that produce saccharifying enzymes (species of the genera *Aspergillus, Mucor, Rhizopus,* etc.).

It is not recommended to translate *saké* as "rice beer" or "rice wine". As a type 3c beverage, *saké* should be clearly distinguished from beer and whiskey (type 3b) or from wine and brandy (type 1). MAURIZIO (1933), although he called *saké* as

Table 1. — Types for the fermentation of alcoholic beverages.

Fermenting material	Enzymes for sugar-formation	Types	Examples*
Sugar	Not necessary	Type 1	Wine; Honey wines; Ethiopian Tej; Sugar cane wines; Palm wines; Mexican Pulque, Colonche and Mezcal; Indian jackfruits wines; Kenyan Urwaga; (Brandy and Rhum) etc.
Lactose in milk	Galactosidase	Type 2	Russian Koumiss and Kefir; Mongolian Airag; (Mongolian Erhi) etc.
Starch	Amylase in saliva	Type 3a	South American maize Chicha; Okinawan rice Miki, etc.
Starch	Amylase in malts	Type 3b	Beers; African Sorghum beer; Mexican Tesguino; Egyptian Bouza; Nigerian Pito; Ethiopian Talla; Kenyan Busaa; Zambian opaque maize beer and Munkoyo; (Whiskey and Vodka) etc.
Starch	Amylase in molds	Type 3c	Japanese Saké, Amazake, and Doburoku; Chinese Shaosing-chu: Korean Takju and Yakju; Malaysian Samsu and Tapai; Philippine Tapuy; Thai rice wine; Indian Ruhi and Pachwai; Indonesian Brem Bali; (Japanese Shochu) etc.

Classification after Nakao (1967), and examples mainly after Steinkraus *et al.* (1983)
* Distilled beverages are put in parentheses.

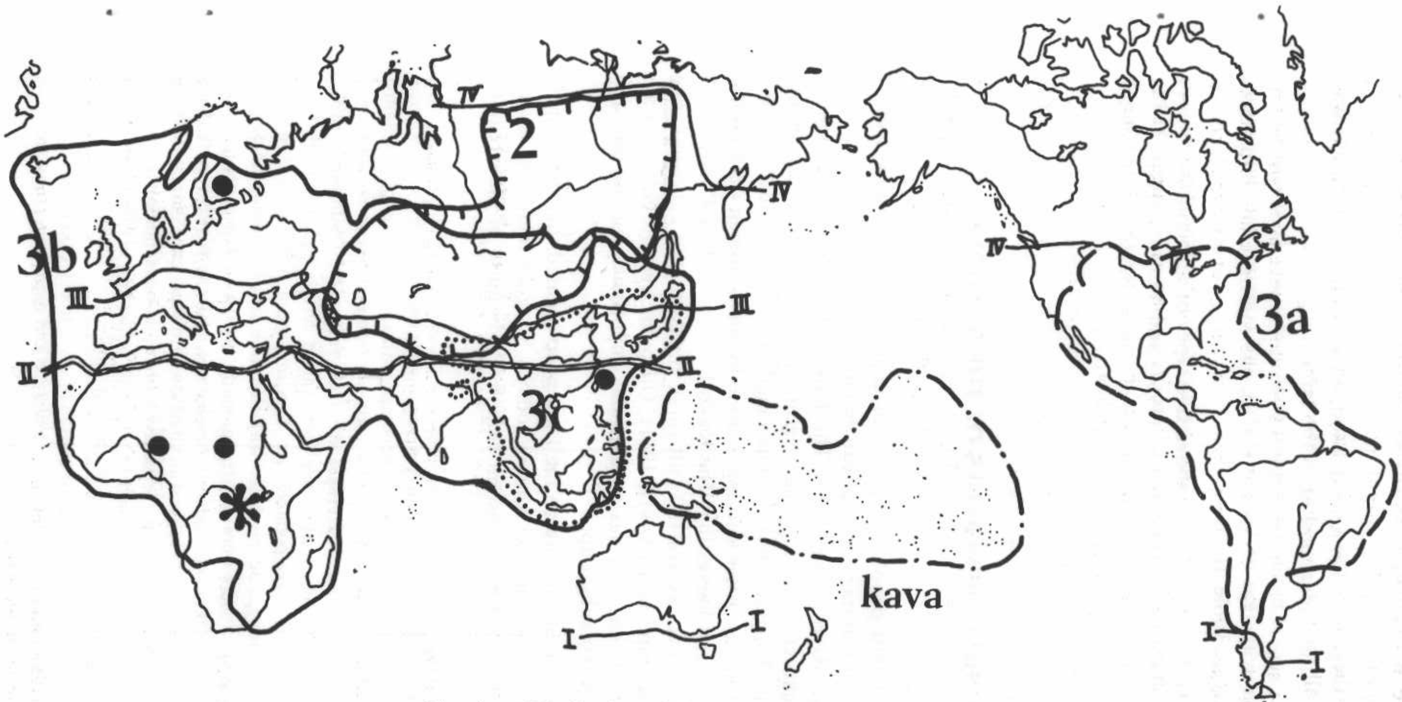

FIG. 1. — Distribution of the types of alcoholic beverages

Adapted from Werth (1954) with revisions.

Type 1, alcoholic beverages based on sugar. I : Southern limits of grape wines, II : Boundary between grape wines to the north and palm wines to the south, III : Northern limit of grape wines, and IV : Northern limits of fruit wines.

Type 2, alcoholic beverages based on milk.

Type 3a, saliva-fermented alcoholic beverages. Closed circles correspond to some of the relics of this type.

Type 3b, malt-fermented alcoholic beverages (solid line). Nakao (1967) notes that the beverages of this type were absent from Japan and China except in very ancient times, and that the existence of indigenous beverages of this type in India is dubious.

Type 3c, mold-fermented alcoholic beverages (dotted line). Yoshida (1986) revised the map of Werth (1954) in the following points : beverages of this type are absent from Hokkaido, northern-most island of Japan, Sri Lanka, and most of India. The existence of the beverages of this type in Central Africa, the principal discovery of this paper, is shown by an asterisk.

Werth also showed the distribution of *kava* (non-alcoholic beverages made of *Piper methystichum*) in the Pacific.

Reisbier, was one of the earlier scholars who realized the distinction of *saké* from beer or wine (2).

The Handbook of Indigenous Fermented Foods (STEINKRAUS *et al.*, 1983) was an excellent contribution to the understanding of the fermenting process of alcoholic beverages, and of the biochemical meaning of traditional operations. Its classification was roughly in accordance with that of WERTH (1954), and contains the indigenous alcoholic beverages quoted in Table 1.

Figure 1 shows the distribution of the above five types of alcoholic beverages of the world after WERTH (1954) revised by NAKAO (1967) and YOSHIDA (1986) as for the 3b and 3c types in Asia. It also shows the existence of type 3c beverages in Central Africa, the major discovery of this paper.

II. — ALCOHOLIC BEVERAGES OF THE SONGOLA

The Songola are a Bantu people composed of at least six subgroups, five of which are slash-and-burn cultivators of the Zairean equatorial forest, the rest practices riverine fishing on the Zaïre River (ANKEI, 1984). This paper is based on a seven-month field study among the Kuko cultivators (village Ngoli), and two months stay among the Enya fishermen (village Tongomacho) (3). Kuko men prepare the fields by felling trees that attain up to 40 meters. After burning is done by men, women do all other works as planting, weeding, and harvesting. The Kuko have more than 45 species of cultivated plants, among which cassava (30 cultivars), plantains (29 cultivars), rice (21 cultivars) are the most important (ANKEI, 1981). Oil palm trees (3 cultivars) are planted in and outside the fields, and has an essential importance for the diet and the economic life of the Kuko subgroup.

DELHAISE (1909) in his ethnography on the Lega people stated that the Songola were well-known for their drunkenness. Among today's Songola there are several restrictions on drinking : some of them abstain completely because of their religion

(2) Among the Japanese traditional alcoholic beverages other than *saké* in a narrow sense, we have *amazake* (literally, sweet *saké*. Turbid, sweet beverage with very low alcoholic contents), *doburoku* (unfiltrated *saké*), *mirin* (sweet beverage for cooking, fermented with an addition of distilled liquor), etc. All these non-distilled beverages are made from rice. Traditional distilled liquors are exclusively called *shochu*, which are made from varied cereals and root crops : rice, barley, maize, sorghum, buckwheat, sweet potatoes, etc. It is important that all these Japanese alcoholic beverages belong with the type 3c, produced with the same genus of molds : *Aspergillus* spp. Although malt-fermented beverages were not traditionally known in Japan, there existed a relic of 3a type beverage, *miki* of Okinawa made by chewing rice until the World War II. There exists a distilled liquor of sugar cane (type 1) in Amami islands where sugar cane plantation began during the Edo era. Thus, the Songola liquor, produced with mold-fermentation of rice has principally the same fermentation process with *saké* in a narrow sense, and is colosest to *shochu*, not only in its manufacture, but also in its color, flavor and taste.

(3) This paper is a revised and much abridged edition of my article (ANKEI, 1987) in which I described the preparation of mold-femented alcoholic beverage and palm wines, and the social and economic significance of alcoholic beverages among the Songola.

(Protestantism, Kimbanguism, or Islam), and the goverment makes it a rule to prohibit the distillation of liquors and preparation of wines from oil palm trees that are regarded important for the production of edible oil. In spite of these restrictions alcoholic beverages have remained one of the most popular beverages for Songola men, and a major source of cash income for many women who engage in the production of distilled liquors.

The Songola call all the alcoholic beverages **màlụ̀** (4), which has the following indigenous varieties : a) **màlụ̀ mí ịbịlà,** fermented sap of oil palm **(ịbílà,** *Elaeis guineensis*), b) **màlụ̀ mí ịbòndò,** fermented sap of Raphia palm **(ịbòndò,** *Raphia* sp.), c) **kuku,** sugarcane juice fermented with 15 % volume of fermented palm sap as starter. Varieties a) and b) are called **màlụ̀ mí màánjị,** (literally "liquor of water"). These palm wines are very popular whereas the sugarcane wine is no longer consumed. Two varieties of distilled liquor, **màlụ̀ mí kàyá** (literally, "liquor of fire") were made until several decades ago : d) distilled palm wines and e) distilled liquor of fermented plaintain bananas. All these beverages are exlusively based on sugar, and are classifed as type 1 alcoholic beverages. The Songola have another varieties of distilled liquor that is the main subject of this paper : f) distilled liquor from a base of mold-fermented rice and cassava. Sometimes maize grains are mixed to supplement rice. In large towns like Kindu and Kibombo, g) twice-distilled liquor of this rice and cassava liquor is sold by the name **cinq cents.**

III. — PROCESS OF PREPARATION OF MOLD-FERMENTED RICE LIQUOR

Unhusked rice **(mùfùngà),** maize **(ịsángú),** and cassava **(mòsòngụ̀)** are prepared separately. The Kuko women regard rice as indispensable for fermentation whereas maize is often omitted. On the contrary, Enya women, having only small fields, often omit rice because unhusked rice is much more difficult to find at the markets than maize. The production is done exclusively by women. The men usually mix and sell the liquor which their wives have made. Consult the flow charts in Figures 2 and 3.

A. Preparation of rice

1. Rice, harvested in February-April, is stored in the form of bundles of ears, and is sometimes stored in a tin as threshed grains before the cropping seasons. Threshing is done by treading the bundles.

2. Unhusked rice grains are put in a mortar **(kìlùngà)** and are roughly crushed with a pestle **(mùtùtí).**

3. Water is poured on the mixture of the husked rice, bran and husks until it becomes wet and homogeneous.

(4) The Songola language is transcribed according to Ankei (1986). It has seven vowels / ị i e a o u ụ / with high /´ / and low /` / tones.

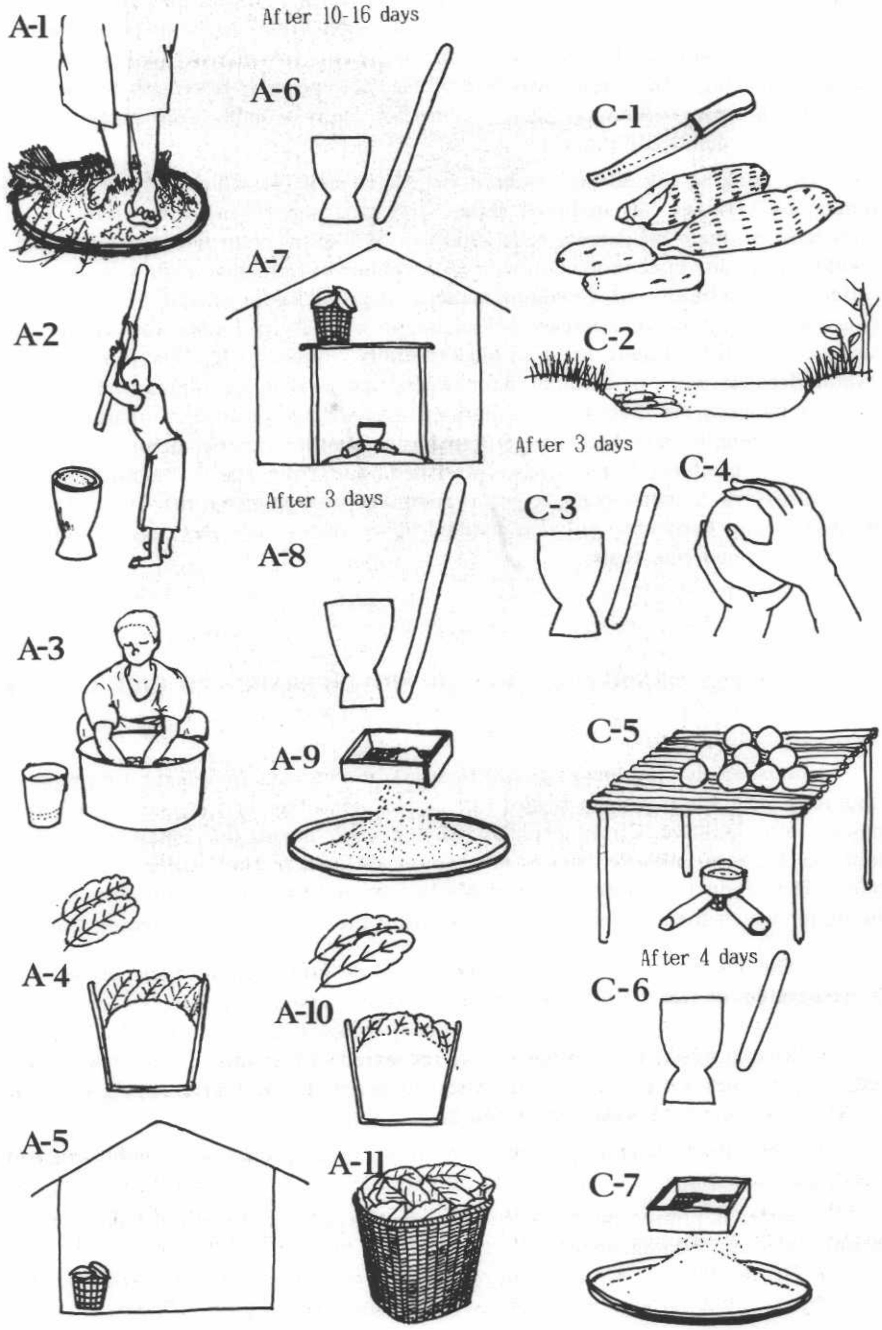

FIG. 2. — Preparation of molds on rice (A) and cassava flour (C).

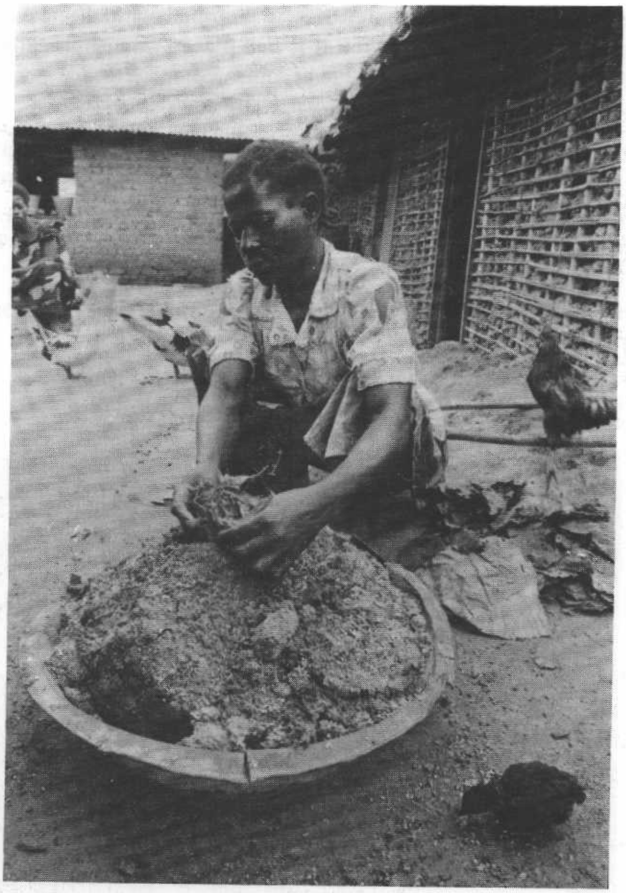

PHOTO 1. — Mold-fermented rice (A-6).

4. The wet mixture is put in a food basket **(kìtútú)** lined with tree leaves, and the content is covered with the same leaves. Trees having large leaves are chosen : *Vernonia conferta* Benth. (Compositae, Songola name **mùbángàlàlá**) and *Caloncoba welwitschii* (Oliv.) Gilg (Flacourtiaceae, **kìlúmbúlúmbù kí mùkálį**). These leaves, used especially for this purpose, have hairy surface whereas the leaves of Marantaceae herbs, usually used for wrapping foods, have a smooth surface.

5. The basket containing 20-30 liters of wet rice is stored at a dark corner of a bedroom or a storeroom. On the fifth or sixth day molds are observed to cover the pounded rice, and the Songola say that at this stage there is already the trace of the specific smell of distilled liquor. Molds are called **lùbùngì** by the Songola (5).

6. On the tenth to sixteenth day, the mixture of rice, transformed into small lumps by molding, is pounded carefully in a morter with a pestle (Photo 1).

(5) The Songola includes in this term the molds growing on any other foodstuffs and also the dense fog from the Zaïre River.

7. The pounded mold-fermented rice is wrapped with the leaves of the trees as in the stage 4, and is put in a basket. It is hen placed on a shelf called **kìlíyá,** over the hearth. After three days, the content becomes completely dry.

8. The dry content is pounded again.

9. The result is now made to pass through a sieve **kàyùngì** on a shallow and wide basket **lùèlį.** Grey powder is obtained as the product of these processes.

10. This powder is covered with the leaves as in the processes 4 an 7. This product is called *vyambo* in Swahili, a word that usually means baits for fishing or baits in a trap for animals.

11. The basket is stored on the food shelf until all is ready for the start of mixture and brewing.

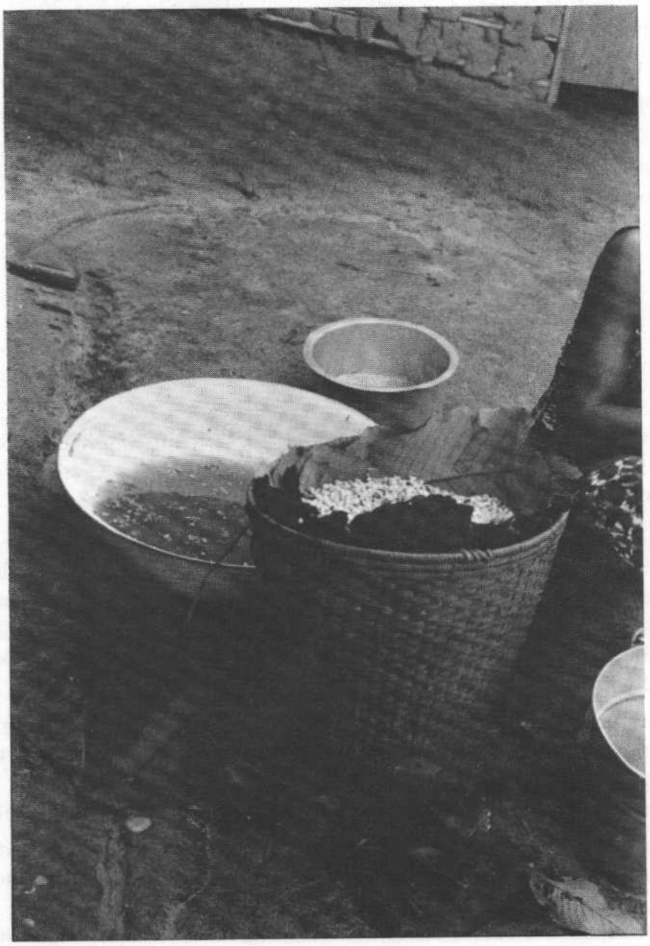

PHOTO 2. — Maize kernels wrapped in tree leaves (B-4).

B. Preparation of maize

Maize is always used to supplement rice among the Kuko whereas it is sometimes used independently among the Enya. The preparation of the maize is not shown in the flow charts because it is practically the same as that of rice (Fig. 2A). The difference from rice is that it is made to sprout before molding.

1. Maize is twice harvested in December-January and in April-May (ANKEI, 1981). Although younger soft ears of maize are cooked, the mature kernels are exclusively used for brewing.

2. The ears are shelled. Unlike rice, the kernels are not crushed.

3. The kernels are soaked in water for two or three days.

4. The soaked kernels are wrapped in the same leaves as in the preparation of rice, and are put in a basket (Photo 2).

5. The basket is placed in a dark corner of a bedroom or a storeroom for three days while the kernels germinate.

6. The germinated kernels are crushed in a mortar.

7. The crushed kernels wrapped in the leaves become covered with molds, and after several days, the smell of distilled liquor begins to become evident.

8. The mold-covered kernels are beaten again in a mortar, but are not made to pass through a sieve, as is the case with rice.

9. The product, also called **vyambo,** is stored separetely from rice in a basket on the food shelf.

C. Preparation of cassava flour

Cassava flour **(lòpòtò)** is prepared from bitter cultivars **(mòsoǹgụ́ wàchụ̀wá).** The tubers are soaked in water in order to dissolve the poisonous cyanide contained in them. The process is the same as that of the preparation of **bùkálì̧ (ugali** in Swahili), one of the staple foods of the Songola.

1. Bitter cassava is peeled, to get rid of the most poisonous parts of the tubers.

2. Peeled tubers are soaked in a shallow pool near the fountain in the forest for about three days. The sodden tubers become soft when the poison is dissolved out. They are put in baskets and are carried back to the village.

3. The sodden tubers are put in a mortar and pestled. Hard, wick-life cores are removed.

4. The beaten tubers are rounded into balls with a diameter of 15-20 centimetres. These balls are called **kìmùndà kí mòsòngụ́.**

5. The cassava balls are dried on a food shelf. It takes about four days until they are dry.

6. The dry cassava balls are beaten in a mortar.

7. The content of mortar is passed through a sieve in a shallow basket to obtain fine bitter cassava flour **(lòpòtò).**

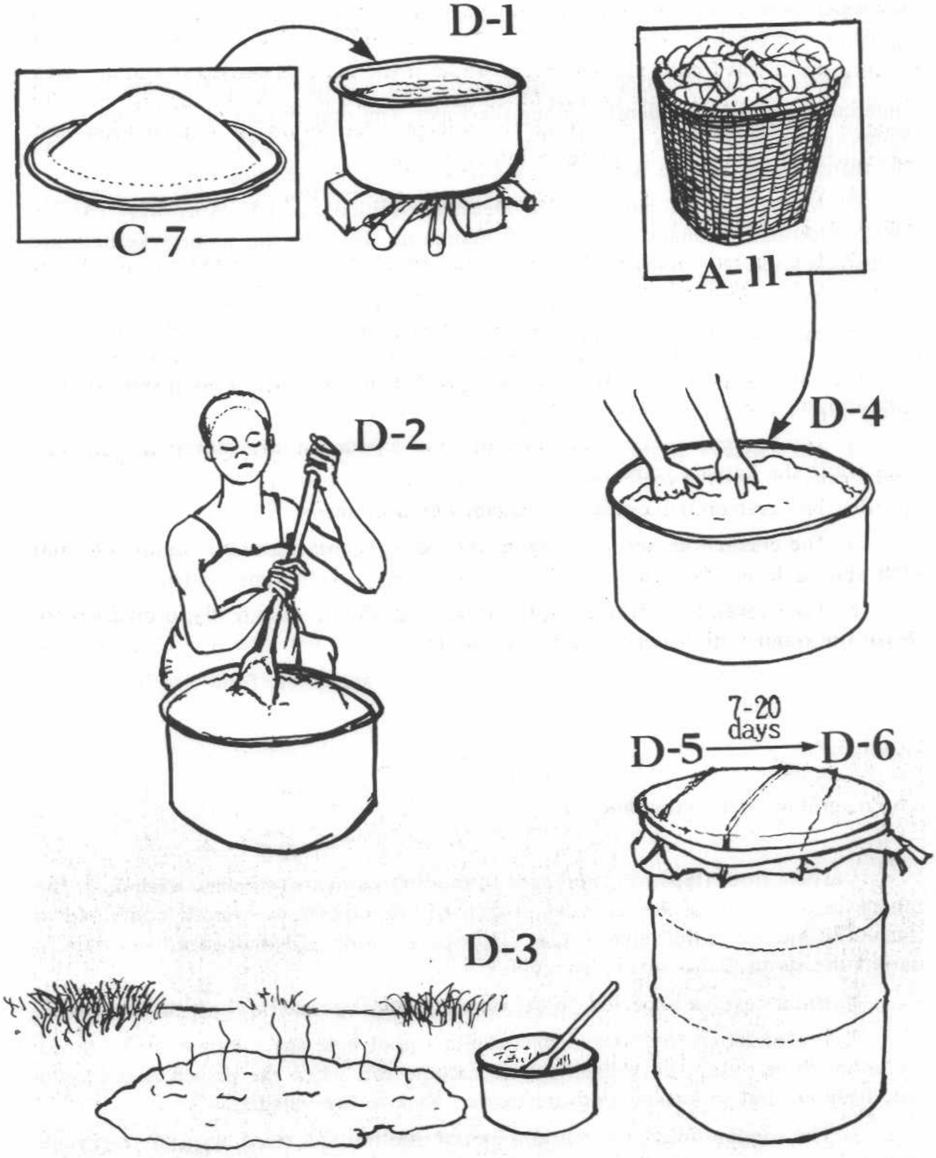

FIG. 3. — Preparation of the mash.

D. Preparation of the mash

The mold-fermented rice (A) and/or germinated and mold-fermented maize (B), and cassava flour (C) are mixed with water to form the mash in which the alcoholic fermentation takes place. The Kuko prefer rice to maize and will not make alcoholic beverages without rice. It takes ten to sixteen days for the preparation of rice and maize, and seven days for cassava flour. The Songola say that rice and maize stand by until the cassava balls are dry. Preparation of the mash is carried out in an open space beside the water. This **kìwànjà kí màlų̀**, or an open space for liquors, is generally situated in the bush not far from the village. The following fermentation and consequent distillation take place in this open space.

1. Water is boiled in a big metal pot. The cassava flour prepared in stage C-7 is poured gradually into the boiling water.

2. The content is kneaded with a long spatula **(mùlúwà)** to make a sticky hot cassava paste, **bùkálį** (Photo 3).

3. The hot cassava paste is spread directly on the ground until it gets cool enough to be touched with hands. This warm cassava paste is returned to the same pot. The cooling process is followed very carefully because the consequent fermentation will fail if the paste is too hot.

4. The cassava paste is mixed with rice and maize powder. One part rice (and/or maize) powder is poured on 2-3 parts cassava paste and the result is carefully kneaded by hand until the mixture becomes homogeneous.

5. The contents is put in an open drum can **(ngùngùlù)**, and is tightly covered with banana leaves **(kàánį)**.

6. After seven to twenty days, the mixture in the drum is ready to be distilled. When the fermentation is completed, the paste becomes soft and fluid. The interval

PHOTO 3. — Making cassava paste (D-2).

from mixing until distilling can be controlled by the thickness of the cassava paste in stage D-2 : soft cassava paste **(bùkálì byá tèmbà)** takes less time than a stiff paste **(bùkàálì byá nùná).**

E. Distillation

The mash that has been well fermented is yellowish brown, and has a characteristic smell. It sometimes contains small fly maggots.

1. A distilling apparatus is set up at the "open space for liquor". It is made up of (a) a large drum can for the mash **(kìngùlùngùlù kí kèlàmbélù̀),** (b) rolled tin pipes **(m̀pópì)** for cooling alcohol vapor, (c) a half-cut drum can **(kèpòlèséò kí màánjì)** for the water that cools the vapor, and (d) glass bottles (Fig. 4). Firewood must be gathered and chopped before distillation.

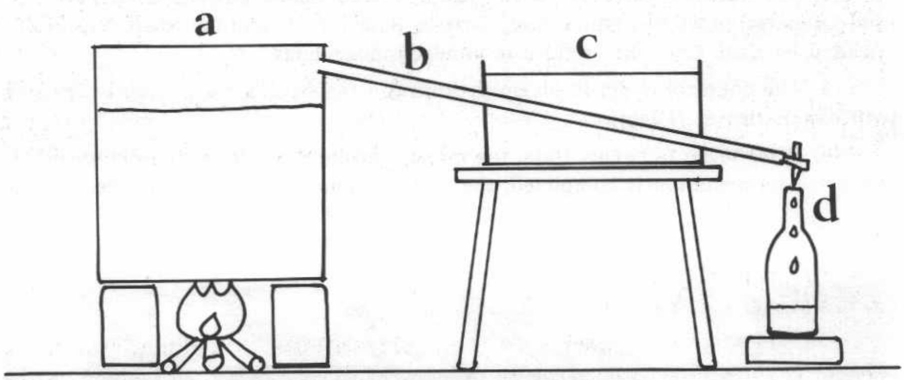

FIG. 4. — Apparatus for distilling Songola liquor.

2. The inside of the large drum can is smeared with a small amount of palm oil. This prevents the mash from burning.

3. The mash put in the drum can (a) for distillation is diluted with a third to two fifths volume of water according to the thickness of the mash (Photo 4). The Songola say that this makes the heating homogeneous and prevents the mash from burning. The diluted content is well stirred with a pole and hands.

4. Firewood beneath the large can (a) is ignitied.

5. An iron plate lid is put on the drum can (a), and the opening is closed with uneaten cassava paste made of the smoked outer parts of the tubers.

6. The smaller can (c) is filled with cold water.

7. The openings are closed with cassava paste.

8. At the first signs of vapor, colorless, tranparent drops containing alcohol come out of the pipe. If the mash is burnt on account of too hot a fire, the liquor becomes brownish and has a burnt smell. The first two or three bottles are very strong and, judging from the taste, contain more than 50 % alcohol. The alcoholic content

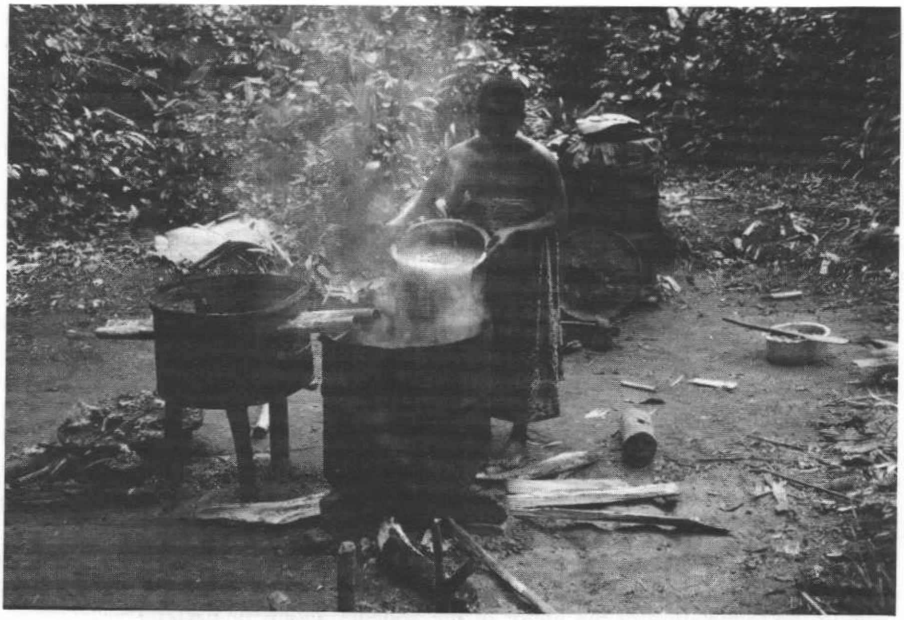

PHOTO 4. — Distilling (E-3).

becomes smaller in later stages of distillation. The cooling water in the smaller can (c) is frequently renewed during distillation.

9. When the drops become practically void of alcohol, the distilling is over. The content of the bottles is mixed in the village. Mixing is, as a rule, the task of the husband of the woman who distillet it. He starts mixing be emptying into a pan the bottles which were distilled last (thus weaker in alcoholic content). When the mixture retains a minimum standard of alcoholic content of the liquor for sale (20-25 %), he stops mixing and puts aside the bottles distilled earlier containing the greatest alcoholic content for his own consumption.

The mash containing mold-fermented rice fills a shallow basket measuring 60 centimetres in diameter. Two basketsful of cassava flour are enough for four distillations, each of which are expected to produce 15-25 bottles containing 720 ml according to the success of fermentation.

IV. — DETERMINATION OF THE FERMENTS AND THE POSSSIBLE SOURCES FOR THEIR STARTERS

A. Determination of the ferments

It is evident that the production of the Songola liquor **(màlu̧ mí kàyá)** is not based on the principles common with wines (tipe 1 of Chapter I), Koumiss (type 2), or Chicha (type 3a).

Although we have not yet succeeded in identifying the microorganisms concerned by way of cultivation or by microscopic observations, we can logically conclude that the molds on rice play the crucial role in the processes of fermentation. This conclusion was inferred from the analysis of the preparation of the rice : A-2 and A-7.

The significance of the process A-2 : all of the rice grains are crushed before being soaked in water, and therefore they never germinate. Thus, the liquor of the Kuko made only with rice and cassava can not be something like beer or whisky (type 3b) in which starch is saccharified by amylase produced by germination of the grains.

During the A—7 stage, the rice powder is dried on the hot food shelf over the fireplace for three days until it becomes completely dried. Under such severe conditions, most of the microorganisms are destroyed, and only those producing dormant spores can survive. Microorganisms that have the ability of producing dormant spores under unfavorable conditions are : some fungi (yeast and mold) and a very limited number of bacteria species (some genera of the familly Bacillaceae) (YANAGITA, 1982 : 86; TERAKAWA, 1984 : 38). Among the spore producing microorganisms, mold and some species in the genus *Bacillus* are known to have the ability of starch hydrolysis (6). So, it is natural to assume the co-existence of yeast, molds, an *Bacillus* species in the rice powder **(vyambo)**. Then, which plays the more important role in the fermetation of the liquor of the Songola, molds or bacteria ?

During the course of the prepartion of the mash, the cassava paste is carefully cooled until it could be handled with hands (stage D-3). Too high a temperature of the cassava paste will result in a failure of the fermetation because it kills the spores of yeast and molds, but not the bacteria spores (7). Thus, at earlier stages both molds and sprore-forming bacteria may contribute to the amylolysis of rice and cassava starch. Numerous species of other (desirable and undesirable) microorganisms undoubtedly begin to grow in the mash because the containers for fermentation are not sterlized (8).

Starch hydrolysis (saccharification) and alcohol formation are not separate processes, and they generally continue rather simultaneously in the mash. Along with the progress of fermentation the mash generally tends to contain acids, as a result of

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(6) *Bacillus subtilis,* for example, is used for the industrialized production of amylase (SAMEJIMA and NARA, 1979 : 199).

(7) Spores of *Bacillus* endure up to 120 degrees centigrade, and are much more resistant against heat than mold spores (HACHISUKA and HORIGOSHI, 1976 : 229; YANAGITA, 1981 : 473; YANAGITA, 1982 : 274). Moreover, it is known that the germination of the spores of this genus is accelerated with heat (ANKEI TAKAKO, 1976).

(8) It will be misleading to suppose that only a limited number of microorganisms are engaged in the fermentation of non-industrialized alcoholic beverages such as the Songola liquor. For example, as many as 24 species of yeasts and molds belonging to 8 genera are found in Indonesian *ragi,* cake-like starter for alcoholic beverages (STEINKRAUS, 1983 : 386). Moreover, the microflora drastically changes during the course of fermentation. Since it is impossible to conserve the changing microflora, he who wants to identify the microflora must carry out sampling, cultivation of the species under different conditions, and microscopic observations all in the field. The difficulty in the scientific study of indigenous fermented beverages exists in these facts.

conversion of some proportion of sugar into acids such as lactic acid. The acid circumstances in the mash makes the growth of *Bacillus* and other microorganisms more and more difficults whereas it does not much inhibit the growth of molds and yeasts (Sakaguchi, 1964 : 185; Steinkraus, 1983 : 348). So, the *Bacillus* species in the mash, if they existed, soon become negligible. In later stages of fermentation only the microorganisms that can endure the high acidity in the mash. In this way, it may be concluded that it is amylolytic molds that play an essential role during the fermentation (saccharification) process of the Songola liquor, and that it deserves the appelation of mold-fermented liquor.

In the region adjacent to the Songola territory, Bigawa (1983) detected that three genera of molds *(Aspergillus, Mucor and Penicillium)* abound of fresh cassava tubers. Since the former two genera are used for the preparation of alcoholic beverages in East Asia, it is probable that some species of the genera *Aspergillus* and *Mucor* are concerned with the liquor of the Songola.

B. Comparison with Asian mold-fermented liquors

The Songola do not add an artificial starter in the mash, and the fermentation seems rather spontaneous. At what stage and from what sources are mold and yeast introduced ?

It is true that mold is always detected on the husks of rice (Iizuka, 1960 : 250-265), and the husks themselves can be one of the sources of mold. In the case of maize, however, the main source may be the leaves used to wrap it at stage B-4. As for the rice, it is probable that these leaves in the stage A-4 are also the principal source of starter for the mold. It may be meaningful that the Songola choose the hairy leaves of two species of trees for wrapping the ferments of their liquor whereas all other foods are wrapped with thin and smooth leaves belonging to an herb family of Marantaceae or with banana leaves.

The specific smell of Songola liquors begins at the stage A-5 for the rice and B-7 for the maize. It is probable that the **vyambo** at these stages already contains the microorganisms that will abound in the mash. Therefore, not only molds but also yeast must have been introduced before these stages. Yeast is presumably derived from the leaves during the A-4 and B-4 stages. It may be introduced again in the mash at the D-3 stage during which cassava paste is spread directly on the ground. Covering the hot cassava paste with soil may be an empirical technique to introduce the yeast which abounds in the soil (Terakawa, 1984 : 215). This technique, however, results in the introduction of a variety of microorganisms that would damage the desired alcoholic fermentation. The large proportion of rice in cassava flour (up to half of the latter) may be a procedure that prevents undesired microorganisms from growing.

Thus, it became most probable that the leaves of trees put in contact with the wet, crushed grains and kernels are the main source of both mold and yeast. Yeast may be introduced again at later stages from the soil to ensure the alcoholic fermentation.

V. — DISCUSSION

A. Mold-fermented alcoholic beverages of Africa : an innovation independent of Asia ?

It has been believed that mold-fermented alcoholic beverages exist only in East and Southeast Asia (NAKAO, 1967 : 376; YOSHIDA, 1986 : 46). We found that the distilled liquor of the Songola is based on rice and/or maize mold. Should such an isolated distribution in Africa be regarded as the result of diffusion from Asia or as an independent innovation ? We will try to find an answer to this question through a comparison of fermenting methods of Asian alcoholic beverages with those of the Songola.

YOSHIDA (1985) classified the traditional alcoholic beverages made from various grains in East and Southeast Asia on the criteria of the "starters" used. He found that mold starters of Asia could be classified into 1) plant starters such as leaves, rice husks, and plant juice, 2) heated or unheated grain starters (further subdivided into milled flour compressed in cakes, full grains, or crushed grains), 3) used mash starters, and 4) spore starters as in today's Japanese **saké.**

The mold-fermented rice liquor of the Songola may be classified as having the leaf (and probably rice husk) starter applied on crushed, unhusked raw rice. We do not find the same procedure among the cumulative listing prepared by YOSHIDA (1985 : 75-114; 1986 : 45-96). The most resembling example from Asia is that of the Lushei-kuki of Nagaland, India. They crush husked rice, wet it, wrap it in leaves, stack the packets, and wait several months until alcoholic beverage oozes out. Among the Asian alcoholic beverages, this example was regarded as rather exceptional and archaic because of the leaf starter applied on uncooked rice. The difference lies in the fact that rice used by the Songola is unhusked.

Thus, mold-fermented rice liquor of the Songola is somewhat similar to one of the most archaic one of Asia. In spite of the apparent antiquity of the starter, the techniques of preparation is much elaborated seeing that if includes distillation and the addition of cassava paste that makes the product strong and cheap. Moreover, rice was introduced in the territory of the Songola only a century ago by the Arab traders coming from the east coast of the continent (ANKEI, 1981 : 124). Further, the technique of preparing cassava flour arrived at the Songola territory in the 50's. To day's rice liquor of the Songola was started only some decades ago, and not a result of ancient diffusion from Asia. And above all, the starter for fermentation is different from those found in Asia. It may be concluded that the mold-fermented alcoholic beverage of Africa was an independent, but much more recent innovation than those in Asia. Then, it may well be asked when and where this innovation took place.

B. Evolution of mold-fermented alcoholic beverages in Africa

The existence of mold-fermented liquor in Africa has long been neglected. The alcoholic beverages prepared with grains and/or tubers were simply "called beers" in most of the descriptions by European and American ethnographers who were ignorant of the molds used as ferments. We can add some more examples from outside the Songola territory, and show that the liquor of the Songola is not a very rare example in Africa.

DALZIEL (1937 : 534) reports that "a native beer is made from rice in Senegal, Nigeria, etc.". A cumulative listing of foods used in Africa (JARDIN, 1970) cites "spirits of rice" from tropical Africa. It is highly probable that these alcoholic beverages were based on mold-fermentation if the rice was the only material used. The reason for this assumption is as follows. When germinated, rice produces a practically negligible amount of amylase, in contrast with other grain crops such as barley (OHTSUKA, 1981 : 2); it is difficult to make type 3b beverage as beer with rice. In this sense the combination of rice and mold-fermentation is to be emphasized.

In the maize liquor of the Enya subgroup; hydrolysis of the starch takes place first by germination, and then by the formation of molds on the crushed kernels. This double operation is assumed to contribute to the stability of fermentation. Maize and cassava liquor is also reported from the Ngandu people who live in the equatorial forest to the west of the Songola (TAKEDA, 1987 : 1087). These examples suggest that the techniques of combining germination and mold formation are veiled in the ethnographic descriptions that have simply reported "beers" based on germination (MIRACLE, 1967).

FUKUI (1970) described the preparation of alcoholic beverages of millet without any germination among the Iraqw of Tanzania. We may suppose that this could be an example of alcoholic beverages that are made by the mold fermentation of grains other than rice and maize.

On the basis of the comparison of rice liquor and the maize liquor of the Songola, we can consider the probable development of the techniques of mold-fermentation in Africa. In the equatorial forests, the alcoholic beverages based on sugar were long dominant because palms, sugar canes, and bananas were easily available, and probably because the Bantu peoples who invaded this forest did not have grain crops as MURDOCK (1959) hypothesized it. Outside the forest, the alcoholic beverages were principally made with germinated grains of type 3b (MIRACLE, 1967).

When maize was introduced in the forest after the sixteenth century, it became possible to prepare alcoholic beverages with germinated maize there. It is natural to suppose that the technique of the combination of germination and mold formation was soon found on account of the humid climate of the forest that favors the development of molds. After several centuries, rice (Asian rice, *Oryza sativa*) arrived in the forest. Some of the cultivators must have tried to apply the same technique of fermentation to rice, and found that the germination of rice did not improve the yield of the product (because of the practical absence of amylase as described above). When the process of germination of rice was omitted because of its inefficiency, the techniques found in today's mold-fermentation of the Songola began. This hypothesis of the omission of germination explains why rice is neither husked nor cooked in the present technique : it retains the characteristics of germinating techniques. These innovations, however, did not become widespread in the forest zones until they were combined with the technique of adding cassava flour (introduced after the sixteenth century). Along with the commencement of distillation, this change brought about strong, cheap, easy to brew alcoholic beverages (9).

(9) In the barter markets of the Songola, a fisherman is expected to get in exchange for his 1 kg fish, 18.9 kg of raw cassava, 8.3 kg of dried poisonous cassava, or 4.9 kg of plantains. Thus, cassava is much easier to obtain than plantains, former materials for the Songola liquors (ANKEI, 1984).

This reconstruction of the emergence of mold-fermented alcoholic beverages in Africa agrees with the hypothesized earliest stages of the development of those in Asia as postulated by YOSHIDA (1986). He assumes that mold-fermented alcoholic beverages in Asia began somewhere in Asia at about 2000 B.C. as a result of the application of germination techniques that developed with barley, to rice, a crop of East Asian origin (YOSHIDA, 1986 : 99; WATABE, 1987). African mold-fermented alcoholic beverages may have been the result of a parallel development that took place much later than in Asia.

In conclusion, this paper revealed the existence of mold-fermented alcoholic beverages in the equatorial forest of Africa, and susggests a wider distribution of such techniques of fermentation. Field and laboratory studies on the microorganisms on one hand, and the re-examination of the ethnographic materials on the other, will provide us with surer clues to the nature and the history of these domesticated microorganisms : molds.

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REFERENCES

ANGLADETTE A., 1966. — *Le Riz.* Maisonneuve et Larose, Paris.

ANKEI Takako, 1976. — Changes in cytochrome contents and respiratory activity of *Bacillus cereus* Strain T during germination, vegetative growth and sporulation. *Plant & Cell Physiol.,* 17 : 305-316.

ANKEI Takako, 1987. — Chûô Ahurika Songôra zoku no sake tsukuri : sono gijutsushi to seikatsushi (Preparation of alcoholic beverages among the Songola, Central Africa : biotechnical and ethnographic notes) in WADA Shohei (ed.). *Ahurika : minzokugaku teki kenkyû (Africa : ethnological studies),* 533-565, Dohosha, Kyoto (in Japanese).

ANKEI Yuji, 1981. — Songôra-zoku no nôkô seikatsu to keizai katsudô (Agricultural livelihood and economic activities of the Songola). *Kikan Jinruigaku (Anthropological Quarterly),* 12 (1) : 96-178 (in Japanese).

ANKEI Yuji, 1984. — Fish as "Primitive Money" : Bater Markets of the Songola. *Senri Ethnological Studies,* 15 (Africa 3) : 1-68, National Museum of Ethnology, Osaka.

ANKEI Yuji, 1986. — Connaissance populaire du poisson chez les Songola et les Bwari : Ethnoichtyologie comparée des pêcheurs du fleuve Zaïre et du lac Tanganyika. *Africana Linguistica,* X : 1-41, Musée royal de l'Afrique centrale, Tervuren (Belgique).

BIGAWA Samuel, 1983. — Les champignons contaminant le manioc frais dans la ville de Kisangani. *Journ. d'Agric. Trad. et de Bota. Appl.* XXX (3-4) : 193-196.

DALZIEL J.M., 1937. — *The Useful Plants of West Tropical Africa,* Crown Agents, London.

DELHAISE C., 1909. — *Les Warega* (Collection de monographies ethnographiques). Bruxelles, 5 : 1-376.

FUKUI Katsuyoshi, 1970. — Alcoholic Drinks of the Iraqw : Brewing methods and social functions. *Kyoto University African Studies,* V : 125-148.

HACHISUKA Yoetsu and HORIKOSHI Hiroki, 1976. — *Taikyûgata saibô (Enduring cells).* Iwanami, Tokyo (in Japanese).

IIZUKA Hiroshi, 1960. — Kome no mikurofurôra (Microflora on rice), in *Biseibutsu no seitai (The ecology of microorganisms).* Institute for Applied Microbiology, The University of Tokyo (in Japanese).

JARDIN Claude, 1970. — *List of Foods used in Africa* (Second edition, revised), F.A.O., Rome.

MAURIZIO A., 1933. — *Geschichte der gegorenen Getränke.* Paul Parey, Berlin. (reprinted 1970).

MINODA Taiji, 1976. — Saketsukuri (Saké manufucture) *Sake : Tôkyô Daigaku kôkai kôza 22 (Saké : 22nd open lectures of the University of Tokyo)* : 3-31, The University of Tokyo Press, Tokyo (in Japanese).

MIRACLE Marvin P., 1976. — *Agriculture in the Congo Basin : Tradition and Change in African Rural Economies.* The university of Wisconsin Press, Madison.

MURDOCK G.P., 1959. — *Africa : its peoples and their culture history.* McGraw-Hill, New York.

NAKAO Sasuke, 1967. — Nôgyô kigen ron (On the origines of agriculture) in *Shizen : Seitaigaku teki kenkyû (Nature : ecological studies)* : 329-494. Chuokoron, Tokyo (in Japanese).

OHTSUKA Kenichi, 1981. — *Jôzô gaku (The science of brewing)* Yokendo. Tokyo (in Japanese).

SAKAGUCHI Kinichiro, 1964. — *Nihon no sake (Saké in Japan)* Iwanami. Tokyo (in Japanese).

SALLÉ Jacques et Bernard, 1986. — *Dictionnaire des alcools,* Larousse, Paris.

SAMEJIMA Hirotoshi and NARA Takashi, 1979. — *Biseibutsu to hakkô seisan (Microorganisms and production by fermentation).* Kyoritsu, Tokyo (in Japanese).

STEINKRAUS Keith H. *et al.* (ed.), 1983. — *Handbook of Indigenous Fermented Foods,* Marcel Dekker, New York.

TAKEDA Jun, 1987. — Nettai shinrin buzoku Ngandu no shokuseitai (Food ecology of the Ngandu, a tribe in the tropical forest) in WADA Shohei (ed.). *Ahurika : minzokugaku teki kenkyû (Africa : ethnological studies)* : 1071-1137, Dohosha, Kyoto (in Japanese).

TERAKAWA Hironori, 1984. — *Kinrui keitô bunruigaku (Phyllogenic taxonomy of the fungi)* Yokendo. Tokyo (in Japanese).

WATABE Tadayo (ed.), 1987. — *Ine no Ajia-shi (Asian History of Rice),* 3 volumes. Shogakukan, Tokyo (in Japanese).

WERTH E., 1954. — *Grabstock Hacke und Pflug.* Eugen Ulmer, Ludwigsburg.

YANAGITA Tomomichi, 1981. — *Biseibutsu gaku* 2 *(Microbiology 2).* Gakkai shuppan center, Tokyo (in Japanese).

YANAGITA Tomomichi, 1982. — *Biseibutsu gaku* 3 *(Microbiology 3).* Gakkai shuppan center, Tokyo (in Japanese).

YOSHIDA Shuji, 1985. — Higashi Ajia no sake no sutâtâ no bunrui to sono hatten (Classification and the development of the starters for alcoholic drinks of East Asia) : in ISHIGE Naomichi (ed.) *Higashi ajia no shokuji bunka (Dietary cultures in East Asia)* : 73-116. Heibonsha, Tokyo (in Japanese).

YOSHIDA Shuji, 1986. — Kabi hakkôshu no kigen : Assamu no sake ni tsuite (The origin of mold-fermented alcoholic beverages : on the alcoholic beverages of Assam). *Kikan jinruigaku (Anthropological Quarterly),* 17 (4) : 45-104 (in Japanese).

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