

This invention relates to a process for the production of a fermented soya sauce.

A traditional oriental process for the production of a fermented soya sauce essentially comprises preparing koji in a first step, preparing and fermenting moromi in a second step and refining in a third step.

In this traditional process, cooked soya beans and/or a cooked, defatted soya flour are mixed with roasted wheat, the mixture is inoculated with a culture of koji or with a pure culture of spores of *Aspergillus oryzae* and/or *Aspergillus sojae*, cultured by aerobiosis and stirred intermittently for one to four days which gives the koji. The koji is mixed with a brine containing approximately 22 to 25% by weight sodium chloride which gives the moromi. The moromi is left to ferment for about 6 to 8 months and then refined by filtration and pasteurization.

A fermented soya sauce obtained by a traditional process such as described above has an α -amino nitrogen content approaching 50% of the total nitrogen.

A major disadvantage of this traditional process is its duration which is necessary for ensuring that the sauce acquires all its aroma through the slow and progressive action - during fermentation of the moromi - of the enzymes produced during preparation of the koji, microorganisms which produce lactic acid and are resistant to the high salt content (halophiles), particularly *Pediococcus halophilus*, and yeasts which produce aromatic substances and alcohol, particularly *Saccharomyces rouxii*.

Accordingly, various processes have been proposed for shortening this duration. US-PS 4,684,527, for example, describes a process which comprises preparing a koji, hydrolyzing the koji and contacting the hydrolyzate with an immobilized peptidase and glutaminase in the presence of salt.

Similarly, US-PS 4,587,127, for example, describes a

process which comprises hydrolyzing a cooked mixture of defatted soya and wheat with a solution of enzymes extracted from a koji, contacting the hydrolyzate with immobilized cells of a halophilic lactic bacterium and then fermenting the whole for a few hours with a yeast of soya sauce.

The object of the present invention is not only to shorten the time required to produce a fermented soya sauce, but also to make it possible to obtain a soya sauce comparable in quality with a fermented soya sauce obtained by a traditional process such as described at the beginning.

To this end, the process according to the invention for the production of a fermented soya sauce is characterized in that a koji is prepared by fermentation with a koji culture of a mixture of cooked soya and roasted wheat, the koji is hydrolyzed in aqueous suspension for 3 to 8 hours at 45 to 60°C and preferably for 4 to 6 hours at 50 to 55°C with the enzymes produced during fermentation with the koji culture, a moromi is prepared by addition of sodium chloride to the hydrolyzed koji suspension, the moromi is left to ferment and is then pressed and the liquor obtained is pasteurized and clarified.

This process effectively enables the duration of the moromi fermentation step to be considerably shortened while, at the same time, ensuring that the proteins and carbohydrates are hydrolyzed to a degree comparable with that obtained in a traditional process such as described at the beginning. The fermentation time of the moromi can thus be reduced from about 6 to 8 months to about 4 to 8 weeks for example.

In the present specification, the expression "koji culture" means a culture of koji spores of the type available commercially, particularly in Japan or China, which comprises in particular spores of *Aspergillus oryzae* and/or

Aspergillus sojae.

Whole soya beans are preferably used for carrying out the process according to the invention. However, in one particular embodiment of the process according to the invention, where the liquor obtained after pressing, pasteurization and clarification is subsequently concentrated, dehydrated and ground, it is also possible to use defatted soya flour for example.

The cooked soya may be prepared by soaking crushed soya beans, i.e. soya meal, for a few hours and then subjecting the meal to a temperature of approximately 120 to 140°C for a few minutes, for example, which guarantees not only cooking, but also sterilization of the meal. The cooked soya meal is then preferably mixed with crushed roasted grains of wheat, i.e. a roasted wheat meal, in a ratio of 50 to 90 parts by weight soya solids to 10 to 50 parts by weight wheat.

After cooling to a suitable temperature of approximately 20 to 40°C and preferably 30 to 35°C, the mixture may be inoculated with a koji culture or with a pure culture of spores of *Aspergillus oryzae* or *Aspergillus sojae* in a ratio of approximately 1 or 2 parts by weight culture to 10,000 parts by weight mixture. The mixture may then be left to ferment for about 30 to 50 hours at 20 to 40°C on traditional screens, on a tray or in a commercial apparatus specially designed for this purpose with intermittent stirring and aeration, preferably two or three times in all. In one particular embodiment of the process according to the invention, the mixture is left to ferment for about 20 to 30 hours at 30 to 40°C and then for 10 to 20 hours at 20 to 30°C which promotes the production of protease by the koji culture.

The koji, which has a solids content of approximately 65 to 75%, may be suspended in water by mixing with water in a ratio of 1 to 3 parts by weight water to 1 part by

weight koji. A relatively small quantity of sodium chloride, namely 0 to 5% and preferably 1 to 3% by weight, may be added to the suspension before hydrolysis. The object of this optional addition of sodium chloride is to exert a plasmolysis effect and thus to contribute towards the release of the enzymes. Mixing and the hydrolysis step itself may be carried out, for example, in a double-jacketed tank equipped with a stirrer.

The hydrolysis step is carried out for 3 to 8 hours at 45 to 60°C and preferably at 48 to 55°C. The outcome of the hydrolysis step is essentially to provide from the outset all the nutrients required for the microorganisms which are involved in fermentation of the moromi whereas, in the traditional process described at the beginning, these nutrients are only gradually released on account of the high salt concentration. These hydrolysis conditions have to be strictly observed to obtain maximum benefit without any risk of contamination.

The results obtained by this hydrolysis are remarkable because, for a total soluble nitrogen of approximately 0.35% by weight of the koji suspension and an α -amino nitrogen of approximately 30% of the total nitrogen, for example, before hydrolysis, values of 1.2, 1.4 and 1.45% for the total nitrogen and values of 41, 48 and 49% for the α -amino nitrogen, for example, are observed after hydrolysis times of 3, 6 and 8 hours, respectively.

To prepare the moromi, sodium chloride may then be added to the hydrolyzed koji suspension in a relatively large quantity, namely in such a quantity that the moromi has a sodium chloride content of approximately 15 to 19% by weight.

The fermentation of the moromi is preferably induced by acidification of the moromi to a pH value favourable to the work of the yeasts of the soya sauce. This acidification may be carried out either chemically, for example by

addition of lactic acid, or biologically by inoculation with a culture of halophilic lactic bacteria. The moromi may be inoculated with a pure culture of *Pediococcus halophilus* for example. This may be done using a quantity of 1 to 2% by volume of a culture containing approximately 10^7 to 10^8 cells of the microorganism per ml. The *P. halophilus* may be left to work for 2 days to 2 weeks and preferably for 3 days at 20 to 35°C so that the pH of the moromi, which initially is about 6.2, falls to a value of approximately 4.8 - 5.5 and preferably to a value of 5.0 to 5.2.

The moromi may then be inoculated with a pure culture of a strain of soya yeast, such as *Saccharomyces rouxii* and/or *Torulopsis etchellsii* for example. This may be done using a quantity of 1 to 5% by volume of a culture containing 10^7 - 10^8 cells of one or other of these microorganisms or of a mixture of these microorganisms. The moromi thus inoculated may be left to ferment for about 2 weeks to 2 or 3 months and preferably for 4 to 8 weeks at approximately 30 to 35°C and preferably at 32 to 34°C with stirring and aeration at least twice a week.

The moromi may then be pressed, for example in a press or a filter press, the insolubles may be removed and the liquor obtained may be pasteurized, for example for 15 to 30 minutes at a temperature of 75 to 90°C. After pasteurization, the liquor is preferably left standing for about 1 to 7 days to allow the insoluble particles which were not removed during pressing to sediment, and is then clarified, for example by passage through a filter paper.

Accordingly, it is possible by the process according to the invention to obtain a fermented soya sauce comparable in taste and aroma with a fermented soya sauce obtained by a traditional process such as described at the beginning.

In one particular embodiment of the process according to the invention, the clarified liquor is concentrated,

dehydrated and ground so that fermented soya sauce is in the form of a powder which may be used as a seasoning or subsequently reconstituted with water in a ratio of 2 or 3 parts by weight water to 1 part by weight powder.

5 To carry out this particular embodiment of the process, the clarified liquor may be concentrated by evaporation for about 30 minutes to 3 hours at a temperature of approximately 55 to 65°C and under a reduced pressure of approximately 100 to 250 mbar. The sauce, which has a
10 solids content of approximately 30 to 34% by weight may thus be concentrated to a solids content of approximately 60 to 85%.

The concentrated liquor may then be dehydrated to a solids content of approximately 95 to 99% by weight, for
15 example under reduced pressure in a dryer in which it may be subjected for about 1 to 10 hours to a temperature of approximately 60 to 100°C and a pressure of approximately 10 to 100 mbar.

Finally, the dehydrated liquor may be ground, for
20 example in a hammer mill, to obtain a fermented soya sauce in the form of a powder in which most of the particles are between 0.5 and 2 mm in size.

In this particular embodiment of the process according to the invention, the koji may also be hydrolyzed in
25 aqueous suspension, for example in admixture with non-hydrolyzed cooked soya. A dehydrated and ground fermented soya sauce of high quality is thus obtained from the hydrolysis of a mixture containing approximately 1 to 2 parts by weight non-hydrolyzed cooked soya solids to 2
30 parts by weight koji solids for example.

The process according to the invention is illustrated by the following Examples in which percentages and parts are by weight, unless otherwise indicated.

Example 1

35 A whole soya meal is soaked in water at ambient

temperature for 3 hours. The soaked meal is cooked and sterilized for 4 minutes at 130°C and then cooled to 30 - 35°C. The soya meal is then mixed with roasted wheat meal in a ratio of 70% soya solids to 30% wheat solids. The resulting mixture is inoculated with a koji culture in a ratio of 1 part culture or spore powder to 10,000 parts mixture. The mixture is left to ferment on screens for 44 hours with stirring and aeration twice in all. 50 kg of the koji thus obtained, which has a solids content of 70%, are suspended in water by mixing with 80 kg water and 1.9 kg sodium chloride in a double-jacketed tank equipped with a stirrer. The resulting koji suspension is hydrolyzed by heating to 54°C and keeping it at that temperature for 5 hours with stirring. Initially, the suspension is stirred slowly and, as the viscosity of the suspension progressively decreases during hydrolysis, the rotational speed of the stirrer is increased to approximately 100 r.p.m. The pH of the suspension, which is 6.3 before hydrolysis, falls progressively to 6.2 during the 5 hours of hydrolysis.

The koji suspension thus hydrolyzed has a total soluble nitrogen content of 1.37% and an α -amino nitrogen content equal to 47% of this total nitrogen.

A moromi is prepared by addition of 17 kg sodium chloride to this hydrolyzed koji suspension. The moromi is inoculated with 1% by volume of a culture of *Pediococcus halophilus* containing 10^7 - 10^8 cells of the microorganism per ml. The moromi is then left to ferment at 30°C for 3 days during which the pH of the moromi falls to a value of 5.0 to 5.2.

The moromi thus acidified is then inoculated with 3% by volume of a mixed culture of *Saccharomyces rouxii* and *Torulopsis etchellsii* containing approximately $5 \cdot 10^8$ cells of each of these microorganisms per ml. The moromi is then left to ferment for 8 weeks at 33°C.

The moromi is then pressed in a press. The liquor is

collected and pasteurized for 20 minutes at 85°C. The pasteurized liquor is left standing for 6 days, the insolubles which have sedimented are removed and the liquor is clarified by passage through a filter paper.

5 The fermented soya sauce obtained in this way is comparable in taste and aroma with a soya sauce obtained by a traditional process such as described at the beginning.

Example 2

10 The procedure is as in Example 1, except that the koji suspension is hydrolyzed for 8 hours instead of 5 hours and the moromi is left to ferment for 4 weeks instead of 8 weeks.

15 The hydrolyzed koji suspension has a total soluble nitrogen content of 1.45% and an α -amino nitrogen content equal to 49% of this total nitrogen.

20 The fermented soya sauce obtained after fermentation of the moromi for only 4 weeks is comparable in taste and aroma with the fermented soya sauce obtained in Example 1.

Example 3

25 A koji is prepared in the same way as described in Example 1 except that a cooked soya meal and a roasted wheat meal are mixed in a ratio of 90% soya solids to 10% wheat solids instead of 70% : 30%.

30 25 kg of this koji, which has a solids content of approximately 60%, and 36 kg cooked and sterilized soya meal, which has a solids content of approximately 47%, are mixed. The resulting mixture is suspended in water by stirring with 57 kg water in a double-jacketed tank equipped with a stirrer. 1 kg sodium chloride is added.

35 The resulting suspension is hydrolyzed by heating at 52°C for 5 hours.

 A moromi is prepared by addition of 17 kg sodium chloride to the hydrolyzed suspension. The procedure is

then as described in Example 1 until the clarified liquor is obtained.

5 The liquor is concentrated for about 2.5 hours at a temperature of approximately 62°C under a reduced pressure of 100 mbar to a solids content of approximately 80%.

The concentrated liquor is then dehydrated under reduced pressure to a solids content of 98% in a dryer where it is subjected for about 6 hours to a temperature of 65 to 85°C and a pressure of 50 mbar.

10 The dehydrated liquor is then ground in a hammer mill equipped with a 1 mm square mesh sieve.

The powder-form fermented soya sauce obtained may be used as a seasoning or may be reconstituted by dispersion in water in a ratio of 1 part powder to 2 parts water. The
15 sauce thus reconstituted has a taste typical of a high-quality fermented soya sauce.

**CLAIMS**

1. A process for the production of a fermented soya sauce, characterized in that a koji is prepared by fermentation with a koji culture of a mixture of cooked soya and roasted wheat, the koji is hydrolyzed in aqueous suspension for 3 to 8 hours at 45 to 60°C with the enzymes produced during fermentation with the koji culture, a moromi is prepared by addition of sodium chloride to the hydrolyzed koji suspension, the moromi is left to ferment and is then pressed and the liquor obtained is pasteurized and clarified.
2. A process as claimed in claim 1, characterized in that the koji is suspended in water by mixing with water in a ratio of 1 to 3 parts by weight water to 1 part by weight koji and in that 0 to 5% sodium chloride is added to the suspension before hydrolysis.
3. A process as claimed in claim 1, characterized in that sodium chloride is added to the hydrolyzed koji suspension in such a quantity that the moromi thus prepared has a sodium chloride content of 15 to 19% by weight.
4. A process as claimed in claim 1, characterized in that, to prepare the koji, 50 to 90%, based on solids, crushed cooked soya beans and 10 to 50%, based on solids, crushed roasted wheat grains are mixed, the resulting mixture of cooked soya and roasted wheat is inoculated with a koji culture and is then left to ferment for 30 to 50 hours at 20 to 40°C with intermittent stirring.
5. A process as claimed in claim 4, characterized in that the mixture of cooked soya and roasted wheat is left to ferment for 20 to 30 hours at 30 to 40°C and then for 10 to 20 hours at 20 to 30°C.
6. A process as claimed in claim 1, characterized in that the koji is hydrolyzed in aqueous suspension for 4 to 6 hours at 50 to 55°C.
7. A process as claimed in claim 1, characterized in



that, after its preparation, the moromi is adjusted to pH 4.8 - 5.5 by biological or chemical acidification, inoculated with a culture of yeast and left to ferment for 2 weeks to 3 months at 30 to 35°C with intermittent stirring and aeration.

8. A process as claimed in claim 7, characterized in that the moromi is adjusted to pH 5.0 - 5.2 by acidification with a culture of *Pediococcus halophilus*, the moromi is inoculated with a culture of *Saccharomyces rouxii* and/or *Torulopsis etchellsii* and is left to ferment for 3 to 6 weeks at 32 to 34°C with stirring and aeration at least twice a week.

9. A process as claimed in claim 1, characterized in that the liquor is pasteurized for 15 to 30 minutes at 75 to 90°C and is then left standing for 1 to 7 days before being clarified.

10. A process as claimed in claim 9, characterized in that the clarified liquor is concentrated to a solids content of 60 to 85% by weight, dehydrated to a solids content of 95 to 99% by weight and reduced to powder.