

PATENT SPECIFICATION (11)

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(54) PROCESS FOR THE PRODUCTION OF BEER WORT USING ENZYMES

(71) WE, CIBA-GEIGY AG, a Swiss Body Corporate of Basle, Switzerland, do hereby declare the invention for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

The present invention relates to a process for the production of beer worts from malt with the aid of added enzymes, and to beer wort so produced.

Malt has been known for a very long time as the base material for the production of beer wort. The raw material used for the production of malt is brewer's barley which initially contains no fermentable extract. As a result of the germination of the barley in the malt house, enzymes, in particular amylases and proteases, are formed, which on mashing convert the content of the barley corn into a soluble form. Thus, the amylases convert the insoluble starch into soluble sugar which can be fermented, and high molecular weight substances such as the barley proteins are degraded by the proteases to give fragments such as polypeptides, peptides and aminoacids which are also necessary for carrying out the brewing process and for the development of certain quality characteristics in the beer. These enzymatic processes occur during "malt mashing", the result of which is the beer wort. The performance of the enzymes present in the malt is thus a prime factor in determining the quality of the beer wort, which in turn greatly influences the brewing process and the quality of the beer produced therefrom. Various factors can be responsible for a poor quality of malt, the most important being severely restricted enzyme activity. Other factors are primarily the quality of the brewer's barleys, which can fluctuate considerably from year to year depending on where the crop is grown and on the climate, and errors in the malting which above all relate to the optimum germination conditions such as moisture, temperature and duration. In most cases it is the combination of several factors which is respon-

sible for a poor quality of malt. The consequences of using such poor quality malts in brewing technology can manifest themselves adversely in various ways during the brewing process itself and in the beer produced. These consequences are *inter alia*, lower extract contents in the worts, very low concentrations of soluble nitrogen compounds in the worts, excessively long saccharification times and clarification times, the danger of subsequent gelatinisation during clarification, poor degrees of fermentation in the final mixture, difficulties in fermentation and problems in filtering the beer. However, such consequences are not exceptional; indeed, because of the various causes mentioned, they tend to occur regularly (see Brauwelt 112, 56 (1972) 1152). The difficulties which occur in the beer wort or in the remaining brewing process are mainly attributable to the poor enzyme activities of the malt, and are largely irreparable and can only be kept within acceptable limits by using additional means employed in brewing technology. This necessarily results in serious economic disadvantages to the breweries concerned.

According to the present invention, there is provided a process for the production of beer wort from malt which is deficient in enzyme activity which comprises mashing the malt in the presence of at least one of the protease obtained from *Aspergillus melleus* IAM 2,006, the protease obtained from *Rhizopus niveus* IAM 6,035, the protease obtained from *Aspergillus niger* IAM 2,020, the α -amylase obtained from *Bacillus subtilis* No. 24 ATCC 21,813, the glucoamylase obtained from *Rhizopus nodosus* FER-P 1,635 and the β -glucanase obtained from *Bacillus subtilis* No. 24 ATCC 21,813, the said enzymes being added before or during the mashing.

The enzymes are isolated from the respective micro-organisms in manner known *per se*, see, for example, J. Agr. Food Chem. 13 No. 1 pp. 30-34 (1965). "IAM" means Institute of Applied Microbiology, Tokyo.

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In the present process, the amount of the protease, based on the weight of malt, is preferably 0.001 to 2.0%, especially 0.002 to 0.2% by weight, the amount of the α -amylase is preferably 0.003 to 6.0%, especially 0.006 to 0.6% by weight, and the amount of the glucoamylase is 0.001 to 2.0%, especially 0.002 to 0.2% by weight. The preferred amount of *B* glucanase is 0.006 to 0.6% by weight, based on the weight, of malt.

The present invention thus makes it possible to compensate the inadequate enzyme activities in lower-quality varieties of malt which are frequently used, so that a beer wort with good technological brewing properties can be produced from such malt batches. Furthermore, the use of the enzymes of the invention results in a substantial saving of time and effort since the time for malting the brewer's barley in the malt houses can be reduced by as much as half by allowing a shorter period for germination. The reduced germination time of the barley has a further important advantage, namely that the so-called "waste" resulting from intensive malting is substantially reduced. This means that the constituents of the barley corn which are valuable for the brewing process and which are degraded by the biochemical processes, such as respiration and formation of the root germ, associated with the process of germination, now remain largely preserved. However, shortening the malting time does not affect the production of the important colorants and flavours in the malt, since kiln-drying, which is an essential part of malting, is not restricted.

The reduction in the enzyme activities inherent in the malt, which would otherwise be associated with a reduction in the period of germination, is compensated by addition, according to the present invention, of the enzymes listed above, in a way which meets practical requirements, so that mashing of malts obtained after short periods of germination presents little difficulty in brewing technology. In addition, an appropriate choice of the amounts of external enzymes results in an advantageous shortening of the mashing time.

The added enzymes used in the invention have the following effects in the malt mash: the proteases bring about degradation of the protein present in the malt to give a proportion of dissolved nitrogen-containing substances which is advantageous for the brewing process, whilst the α -amylase causes a rapid liquefaction of the malt starch, which results in optimum extract contents in the wort. The glucoamylase produces a general increase in the final degree of fermentation of the wort, as a result of rapid saccharification. The *B*-glucanase, by lowering the viscosity of the mash, which is mainly attributable to malt of poor solubility, accelerates clarification so that the separation of the wort from the draff can be quickly and easily carried out in a clarifying tub or filter press.

The process of the invention is performed in

manner known *per se* in brewing technology, i.e. usually at a pH of 3.5 to 6.0 and at a temperature of 20° to 95°C, the recommended enzymes being added to the malt mash either before or during the mashing.

The present invention is illustrated by the following example; percentages are by weight.

Example

The activity of the enzyme additives in bringing about the desired quality characteristics in the beer wort produced from malt is most rapidly assessed with the aid of Congress wort (i.e. an assay taken from the bulk of the malt to test its quality).

For this purpose, two sorts of malt of reduced quality (4 day malt) and normal quality (8 day malt) are produced from brewer's barley of normal degree of steeping, using a germination temperature of 15°C and germination times of different duration (4 and 8 days). The malt which is kiln-dried is then separately ground by means of a Casella mill to give coarsely ground malt, as used in practice, containing 25% of flour.

50 g of the 4 day malt are mixed with 150 ml of water and warmed to 63°C whilst stirring, and 20 mg of the protease obtained from *Aspergillus melleus* IAM 2,066, 30 mg of the α -amylase obtained from *Bacillus subtilis* No. 24 ATCC 21813, 20 mg of the glucoamylase obtained from *Rhizopus nodosus* FER-P1,635, and 30 mg of the *B*-glucanase obtained from *Bacillus subtilis* No. 24 ATCC 24,813 are added. The mixture is stirred for a further 30 minutes at 63°C and then warmed to 70°C, the temperature being raised at the rate of 1°C per minute. The suspension is kept for 30 minutes at 70°C.

Thereafter, important quality characteristics relating to brewing technology are tested in the mash thus produced.

In the same way as described above, the 8 day malt is mashed but, without added enzyme, for comparative purposes. In this case however, the mashing time is extended to 153 minutes and the temperature is regulated as follows: at the beginning of mashing the temperature is 50°C which is maintained for 30 minutes. The temperature is then raised to 63°C at the rate of 1°C per minute, and maintained for 30 minutes at this temperature and then raised again at the rate of 1°C per minute, to 70°C. This temperature is then maintained for 30 minutes.

Thereafter, important quality characteristics relating to brewing technology are tested in the mash obtained.

Assessment

The extract content, concentrations of soluble N compounds and α -amino-N compounds, final degree of fermentation, viscosity values, colour (EBC), run-off, saccharification time (in minutes and pH value of the wort produced from 4 day malt, with added enzymes and with the mashing time shortened by 40% show values

which are largely comparable with those of the comparative batch with 8 day malt and without added enzymes.

5 In our copending Application No. 49561/73 (Serial No. 1442401), we describe and claim a process for the production of beer wort which comprises mashing unmalted grain optionally in admixture with other extract-yielding material such that the proportion of unmalted grain is 10 20 to 100% by weight, based on the total weight of the extract-yielding material, in the presence of 0.004 to 5.0% by weight, based on the weight of unmalted grain, of the α -amylase obtained from *Bacillus subtilis* No. 24 ATCC 21813, the 15 glucoamylase obtained from *Rhizopus nodosus* FER-P 1,635, the *B*-glucanase obtained from *Bacillus subtilis* No. 24 ATCC 21,813, and at least one of the protease obtained from *Aspergillus melleus* IAM 2,066, the protease obtained from *Rhizopus niveus* IAM 6,035, and the pro- 20 tease obtained from *Aspergillus niger* IAM 2,020, the said enzymes being added either before or during the mashing.

WHAT WE CLAIM IS:

25 1. Process for the production of beer wort from malt which is deficient in enzyme activity which comprises mashing the malt in the presence of at least one of the protease obtained from *Aspergillus melleus* IAM 2,066, the pro- 30 tease obtained from *Rhizopus niveus* IAM 6,035, the protease obtained from *Aspergillus niger* IAM 2,020, the α -amylase obtained from

Bacillus subtilis No. 24 ATCC 21813, the glucoamylase obtained from *Rhizopus nodosus* FER-P 1,635 and the *B*-glucanase obtained from *Bacillus subtilis* No. 24 ATCC 21813, the said 35 enzymes being added before or during the mashing.

2. Process according to Claim 1, wherein the amount of the protease is 0.001 – 2.0% by 40 weight, the amount of the α -amylase is 0.003 – 6.0% by weight, and the amount of the glucoamylase is 0.001 – 2.0% by weight, based on the weight of malt.

3. Process according to Claim 1, wherein the 45 amount of the protease is 0.002 – 0.2% by weight, the amount of the α -amylase is 0.006 – 0.6% by weight, the amount of the glucoamylase is 0.002 – 0.2% by weight, and the amount of *B*-glucanase is 0.006 – 0.6% by weight, based 50 on the weight of malt.

4. Process according to claim 1 substantially as described in the foregoing Example.

5. Beer wort produced by a process as 55 claimed in any one of the preceding claims.

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which are largely comparable with those of the comparative batch with 8 day malt and without added enzymes.

5 In our copending Application No. 49561/73 (Serial No. 1442401), we describe and claim a process for the production of beer wort which comprises mashing unmalted grain optionally in admixture with other extract-yielding material such that the proportion of unmalted grain is 10 20 to 100% by weight, based on the total weight of the extract-yielding material, in the presence of 0.004 to 5.0% by weight, based on the weight of unmalted grain, of the α -amylase obtained from *Bacillus subtilis* No. 24 ATCC 21813, the 15 glucoamylase obtained from *Rhizopus nodosus* FER-P 1,635, the *B*-glucanase obtained from *Bacillus subtilis* No. 24 ATCC 21,813, and at least one of the protease obtained from *Aspergillus melleus* IAM 2,066, the protease obtained from *Rhizopus niveus* IAM 6,035, and the protease obtained from *Aspergillus niger* IAM 2,020, the said enzymes being added either before or during the mashing.

WHAT WE CLAIM IS:

25 1. Process for the production of beer wort from malt which is deficient in enzyme activity which comprises mashing the malt in the presence of at least one of the protease obtained from *Aspergillus melleus* IAM 2,066, the protease obtained from *Rhizopus niveus* IAM 6,035, the protease obtained from *Aspergillus niger* IAM 2,020, the α -amylase obtained from

Bacillus subtilis No. 24 ATCC 21813, the glucoamylase obtained from *Rhizopus nodosus* FER-P 1,635 and the *B*-glucanase obtained from 35 *Bacillus subtilis* No. 24 ATCC 21813, the said enzymes being added before or during the mashing.

2. Process according to Claim 1, wherein the amount of the protease is 0.001 – 2.0% by 40 weight, the amount of the α -amylase is 0.003 – 6.0% by weight, and the amount of the glucoamylase is 0.001 – 2.0% by weight, based on the weight of malt.

3. Process according to Claim 1, wherein the 45 amount of the protease is 0.002 – 0.2% by weight, the amount of the α -amylase is 0.006 – 0.6% by weight, the amount of the glucoamylase is 0.002 – 0.2% by weight, and the amount of *B*-glucanase is 0.006 – 0.6% by weight, based 50 on the weight of malt.

4. Process according to claim 1 substantially as described in the foregoing Example.

5. Beer wort produced by a process as 55 claimed in any one of the preceding claims.

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