Title: PROCESS FOR THE PRODUCTION OF AN EDIBLE PASTA FROM DURUM WHEAT HAVING A HIGH NUTRITIONAL POTENTIAL AND EDIBLE PAST FROM DURUM WHEAT HAVING A HIGH NUTRITIONAL POTENTIAL

Abstract: The present invention refers to a process for the production of an edible pasta from durum wheat having a high nutritional potential as well as to an edible pasta from durum wheat having a high nutritional potential, which according to the invention retains functional nutrients - particularly arabinoboxylans and alkylresorcinols - within their natural matrix, thus amplifying their availability to the consumer: an edible pasta is thus obtained which can be provided with novel compositional aspects for unusual nutrients, which confer to said pasta a nutritional potential qualitatively higher than that of conventional edible pasta obtained solely from durum wheat flour. The present invention further refers to an edible pasta from durum wheat with a high nutritional potential particularly rich of compounds having a high nutritional potential and, particularly, of arabinoboxylans and alkylresorcinols.

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"Process for the production of an edible pasta from durum wheat having a high nutritional potential and edible pasta from durum wheat having a high nutritional potential"

DESCRIPTION

Technical Field of the Invention

The present invention refers to a process for the production of an edible pasta – in particular of an edible pasta from durum wheat – having a high nutritional potential.
The present invention also refers to an edible pasta from durum wheat with a high nutritional potential.

Prior Art

Cereals (mainly wheat, rice, maize, barley, oat, rye) are consumed all over the world as dietary basis because they are a primary source of energy deriving from the polysaccharides present therein and, in particular, from the high content of starch of their endosperm, which is located in the central portion of the caryopsis and forms the main part thereof.

With special respect to wheat, one distinguishes among soft wheat (*Triticum aestivum ssp vulgare*), which is used mainly for the making of bread products and yeasted products, and durum wheat (*Triticum turgidum ssp. durum*), which is used mainly for the making of pasta.

Flour, which is the main product obtained from the conventional process of grinding of durum wheat, is used for the making of pasta from durum wheat. It consists of the innermost parts of the caryopsis (endosperm) after separation from the outermost ones (bran) and elimination of the germ.

In order to obtain flour, durum wheat grain is subjected to a grinding step (breaking of caryopses) and to a subsequent step of bolting aimed at separating to the maximum possible extent the endosperm fractions, which will form the final raw material, from the other components of the caryopsis.
The flour thus obtained is satisfactorily suitable for the subsequent process of pasta-making for producing an edible pasta and allows to obtain an end product with satisfactory organoleptic properties that meet the consumer’s demands and with good results upon cooking test in terms of stickiness, firmness and bulkiness in the cooked product.

However, in the light of the increasing attention over the last decades to a healthy and nutritive feeding, the edible pasta thus obtained has a serious drawback in that, as is known, the outer fractions of the caryopsis are very rich of other nutritionally important compounds and elimination of these in order to obtain durum wheat flour by using solely the endosperm reduces the nutritional potential of the conventional durum wheat pasta.

On the other hand, durum wheat pasta obtained from whole durum wheat flour - i.e. raw material (flour or semolina) obtained by grinding whole caryopses, without bran elimination, finds little recognition on the market, especially because it has organoleptic qualities that are little appreciated by consumers.

The main object of the present invention is therefore the standardization of a production process that enables to make an edible pasta - in particular a durum wheat pasta - that, while partially retaining parts of the outer layers richer of specific bioactive components, has a nutritional potential higher than that of conventional durum wheat pasta. Another object of the present invention is to obtain an edible pasta - in particular a durum wheat pasta - with a high nutritional potential in which the organoleptic properties and the values of the parameters of the cooking test are not impaired.

These and other objects are achieved by means of a process for the production of an edible pasta and by a durum wheat edible pasta as claimed in the appended claims.
Summary of the Invention

The inventors' attention has focused especially on two bioactive compounds of remarkable interest: arabinoxylans and alkylresorcinols.

Arabinoxylans are polysaccharides belonging to the category of emicelluloses and represent the most abundant components among non-amylaceous polysaccharides of wheat. An important property of arabinoxylans is their capability of forming highly viscous solutions, this property having a remarkable impact on the nutritional potential of wheat. Indeed, effects similar to those of soluble fibers have been attributed to arabinoxylans because of their potential capability of modulating blood levels of cholesterol and glucose.

Alkylresorcinols (or more precisely 5-n-alkylresorcinols) are phenolic lipids that have recently raised great interest because of the possibility to develop products with functional characteristics in connection with their potential anti-oxidant power and their capability of preventing oxidation of membrane lipids with positive effects also on cancer prevention. Furthermore, their capability of exerting a wide range of biological activities related to their amphiphilic nature, such as in particular a remarkable anti-microbial activity, has been documented. The edible pasta according to the invention retains its functional nutrients - and in particular arabinoxylans and alkylresocinols - within their natural matrix, thus amplifying their availability to the consumer.

In particular, the edible pasta according to the invention has a content of arabinoxylanas higher than that of conventional durum wheat pasta by an amount of no less than 20% and a content of alkylresocinols higher than that of conventional durum wheat pasta by an amount of no less than
40%.

In a preferred embodiment of the invention, the content of arabinoxylans of the edible pasta according to the invention is approximately 50% higher than that of conventional durum wheat pasta and the content of alkylresorcinols of the edible pasta according to the invention is approximately 100% higher than that of conventional durum wheat pasta. Contrary to whole durum wheat pasta, the edible pasta according to the invention shows organoleptic properties and results upon cooking test that are totally comparable to those of conventional durum wheat pasta.

The edible pasta according to the invention is obtained by a novel production process that provides for mixing a portion of coarse meal obtained from caryopses that have been slightly decorticated, i.e. deprived of the first layer of pericarp, with a conventional portion of durum wheat flour. Preferably, said portion of coarse meal obtained from slightly decorticated caryopses constitutes between 25% and 50% by weight of the final integrated flour.

In a preferred embodiment of the invention, the step of grinding said caryopses is effected by means of micronization.

Preferably, said grinding by micronization is followed by a separation step for obtaining fractions with homogeneous particle size, and only one of these fractions is mixed with said portion of durum wheat flour.

In a preferred embodiment of the invention, after integrating the durum wheat flour with said coarse meal obtained from slightly decorticated caryopses, the integrated flour thus obtained is subjected to a sieving step.

Advantageously, said sieving step allows to eliminate the grossest particles and to avoid, in the subsequent pasta-making step, the drawbacks that may be caused by said
grossest particles.

Brief Description of the Drawings
The invention will be better understood with the aid of the ensuing description of a preferred embodiment of the invention itself, given by way of non-limiting example with reference to the attached Figure, which shows a block diagram schematically illustrating the main steps of the production process according to the invention.

Detailed Description of the Invention
With reference to the attached Figure, the process for the production of edible pasta according to the invention provides for starting with the provision of an appropriate amount of durum wheat grain (caryopses) (step 101).

A first portion of said durum wheat grain is subjected to a conventional process of grinding and subsequent bolting until a conventional durum wheat flour is obtained (step 110).

It should be noted that, in this context, “conventional durum wheat flour” means a durum wheat ground product that meets the requirements of Art. 2 of the Decree of the President of the Italian Republic No. 187 of February 9, 2001.

According to the invention, a remaining second portion of durum wheat grain is subjected to a slight decortication step (step 103), intended to partially remove the outer woody fraction of the caryopses.

The grain thus decorticated is subsequently subjected to grinding (step 105). In particular, according to a preferred embodiment the decorticated grain is subjected to grinding by micronization, preferably in a micronizer at a speed of about 170 Hz.

A coarse meal of fine particle size is thus obtained, rich of specific compounds with high nutritional potential and, in particular, of arabinoxylans and alkylresorcinols.
According to a particularly simple embodiment of the invention, said coarse meal could be directly mixed with the conventional durum wheat flour, thus obtaining an integrated product with an increased content of arabinoxylans and alkylresorcinols, which could be used for obtaining an edible pasta.

However, according to the preferred embodiment described herein, the obtained coarse meal is subjected to a separation step in order to obtain two or more fractions having a homogeneous particle size (step 107). In particular, in the example described, said coarse meal is subjected to a turboseparation step in order to obtain two distinct fractions, one fraction with gross particle size G and one fraction with fine particle size F.

Table 1 given here below clearly shows that both the fraction with gross particle size G and the fraction with fine particle size F have a content of total arabinoxylans and alkylresorcinols remarkably higher than that of conventional durum wheat flour.

<table>
<thead>
<tr>
<th>Kind of coarse meal</th>
<th>Total arabinoxylans [g DM*]</th>
<th>Alchilresorcinol [μg/g DM*]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional durum wheat flour</td>
<td>1.70 ± 0.07</td>
<td>93.2 ± 2.9</td>
</tr>
<tr>
<td>Coarse meal - fraction G</td>
<td>3.79 ± 0.30</td>
<td>287.1 ± 19.2</td>
</tr>
<tr>
<td>Coarse meal - fraction F</td>
<td>3.78 ± 0.33</td>
<td>311.4 ± 52.5</td>
</tr>
</tbody>
</table>

*dry matter

The results reported in Table 1 refer to tests carried out on three different durum wheat varieties (Neodur, Creso and Kofa) and are expressed as mean value and standard deviation obtained from the analysis of said three varieties.

According to the invention, one of said fractions G or F of said coarse meal at this time is mixed with the conventional
durum wheat flour (step 109).
Preferably, the integrated flour thus obtained will contain
a portion between 25% and 50% by weight of one of said
fractions G or F.

Said integrated flour can be advantageously used as raw
material in a pasta-making process.
However, in the preferred embodiment of the invention to
which the Figure refers, the integrated flour thus obtained
is subjected to a sieving step (step 111). In particular,
said sieving step can be carried out with a sieve having a
mesh size of 1 mm.
Advantageously, said sieving step allows to eliminate the
grossest particles that can determine a final product
(pasta, for instance in the format of spaghetti) that is
less homogeneous and tends to crack where said grossest
particles concentrate.
Table 2 given here below refers to two examples of
integrated flours obtained in accordance with the invention,
and in particular:

- a first integrated flour containing 75% by weight of
  conventional durum wheat flour and 25% by weight of
  fraction with gross particle size G (integrated flour
  SG);
- a second integrated flour containing 50% by weight of
  conventional durum wheat flour and 50% by weight of
  fraction with gross particle size F (integrated flour
  SF).

The values reported in Table 2 clearly show that both
integrated flours taken into consideration have a content of
total arabinoxylans and alkylresorcinols remarkably higher
than that of conventional durum wheat flour.
In particular the integrated flour having the highest
integration grade (integrated flour SF) has particularly
satisfying values.
Table 2

<table>
<thead>
<tr>
<th>Kind of coarse meal</th>
<th>Total arabinoxylans [% DM*]</th>
<th>Alkylresorcinols [µg/g DM*]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional durum wheat flour</td>
<td>1.70 ± 0.07</td>
<td>93.2 ± 2.9</td>
</tr>
<tr>
<td>Integrated flour SG</td>
<td>2.00 ± 0.31</td>
<td>135.2 ± 4.2</td>
</tr>
<tr>
<td>Integrated flour SF</td>
<td>2.78 ± 0.33</td>
<td>206.2 ± 23.0</td>
</tr>
</tbody>
</table>

*dry matter

In this case, too, the results reported in Table 2 refer to tests carried out on three different durum wheat varieties (Neodur, Creso and Kofa) and are expressed as mean value and standard deviation obtained from the analysis of said three varieties.

The integrated flours thus obtained are subjected to a step of pasta-making step (step 113) - known per se – which allows to obtain the edible pasta according to the invention.

In Tables 3a and 3b the main features of edible pastas according to the invention obtained from the two examples of integrated flours indicated above are compared with the homologous features of an edible pasta obtained from pure conventional durum wheat flour.

Table 3a

<table>
<thead>
<tr>
<th>Kind of pasta</th>
<th>Total arabinoxylans [% DM*]</th>
<th>Alkylresorcinols [µg/g DM*]</th>
<th>Total dietary fiber [% DM*]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasta from conventional durum wheat flour</td>
<td>1.80 ± 0.30</td>
<td>88.7 ± 5.3</td>
<td>3.0 ± 0.5</td>
</tr>
<tr>
<td>Pasta from integrated flour SG</td>
<td>2.21 ± 0.33</td>
<td>133.0 ± 4.7</td>
<td>-</td>
</tr>
</tbody>
</table>
Pasta from integrated flour SF  |  2.70 ± 0.26  |  192.7 ± 15.7  |  4.8 ± 0.3

*dry matter

Table 3b

<table>
<thead>
<tr>
<th>Kind of pasta</th>
<th>Humidity [%]</th>
<th>Total proteins [% DM*]</th>
<th>Total starch [% DM*]</th>
<th>Resistant starch [% DM*]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasta from conventional durum wheat flour</td>
<td>11.0 ± 0.9</td>
<td>15.0 ± 0.2</td>
<td>66.6 ± 1.0</td>
<td>0.50 ± 0.04</td>
</tr>
<tr>
<td>Pasta from integrated flour SG</td>
<td>11.0 ± 0.9</td>
<td>-</td>
<td>65.0 ± 0.10</td>
<td>0.52 ± 0.04</td>
</tr>
<tr>
<td>Pasta from integrated flour SF</td>
<td>10.5 ± 0.3</td>
<td>15.5 ± 0.5</td>
<td>63.6 ± 3.0</td>
<td>0.47 ± 0.09</td>
</tr>
</tbody>
</table>

*dry matter

As in the preceding cases, the results reported in Tables 3a and 3b refer to tests carried out on three different durum wheat varieties (Neodur, Creso and Kofa) and are expressed as mean value and standard deviation obtained from the analysis of said three varieties.

The results of Table 3a indicate a substantial improvement of the nutritional potential obtainable with the edible pastas according to the invention: the pasta obtained from integrated flour SF has an increase by over 20% of total arabinoxylans (i.e. > 2.15% DM with respect to 1.70% DM) and by over 40% of alkylresorcinols (i.e. > 125,0 μg/g DM with respect to 98,0 μg/g DM) with respect to the pasta obtained from conventional durum wheat flour; the pasta obtained from integrated flour SF has an increase by about 50% of total di arabinoxylans, and by about 100% of alkylresorcinols with respect to the pasta obtained from conventional durum wheat
flour. Furthermore, the pasta obtained from integrated flour SF has an increase by about 60% of total dietary fibers with respect to the pasta obtained from conventional durum wheat flour (see Table 3a).

The other parameters taken into account do not exhibit relevant differences, as shown in Table 3b. In order to assess the potential approval of edible pasta according to the invention by consumers, the organoleptic properties of said edible pasta as well as the results of the cooking test have been considered.

Table 4 reports the opinions relating to the parameters of the cooking test for edible pastas according to the invention obtained from the two examples of integrated flours indicated above, compared with the homologous parameters of an edible pasta obtained from conventional durum wheat flour.

Three different tasters expert in the field were made to taste the edible pastas that have been considered and expressed an opinion on a centesimal scale from 10 (very poor quality) to 100 (excellent); Table 4 reports the mean values obtained by combining the opinions of the three tasters.

Table 4

<table>
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<tr>
<th>Kind of pasta</th>
<th>Stickiness</th>
<th>Firmness</th>
<th>Bulkiness</th>
<th>Global opinion</th>
</tr>
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<tbody>
<tr>
<td>Pasta from conventional durum wheat flour</td>
<td>45.0 ± 10.0</td>
<td>71.7 ± 2.9</td>
<td>51.7 ± 2.9</td>
<td>56.1 ± 3.8</td>
</tr>
<tr>
<td>Pasta from integrated flour SG</td>
<td>50.0 ± 0.0</td>
<td>66.7 ± 2.9</td>
<td>55.0 ± 5.0</td>
<td>57.8 ± 2.5</td>
</tr>
<tr>
<td>Pasta from integrated flour SF</td>
<td>55.0 ± 5.0</td>
<td>63.3 ± 5.8</td>
<td>60.0 ± 0.0</td>
<td>59.4 ± 2.5</td>
</tr>
</tbody>
</table>
In this case, too, the results reported in Table 4 refer to tests carried out on three different durum wheat varieties (Neodur, Creso and Kofa) and are expressed as mean value and standard deviation obtained from the analysis of said three varieties.

As is clear from Table 4, no substantial differences with respect to the pasta obtained from conventional durum wheat flour have been found.

This is to be attributed mainly to the step of initial slight decortication, which - although it does not eliminate the components of the caryopses rich of arabinoxylans and alkylresorcinols - allows to remove the outer, more woody and gross parts of the caryopses, which risk to make the pasta-making process more difficult and to impair the organoleptic features of the end product.

It is therefore evident from what has been described above that the invention attains the objects set forth above, as it provides an edible pasta comprising unusual nutrients (arabinoxylans and alkylresorcinols) that confer to said pasta a nutritional potential qualitatively higher than that of conventional durum wheat pasta obtained solely from durum wheat flour.

It is further evident that the above description has been given by way of non-limiting example and that several variants and modifications falling within the scope of the present invention as defined in the appended claims are within the reach of the person skilled in the art.
CLAIMS

1. Process for the production of an edible pasta starting from durum wheat grain, comprising the steps of:
   - providing a certain amount of durum wheat grain (101);
   - grinding and bolting a first portion of said amount of durum wheat grain in order to obtain durum wheat flour (110);
   characterized in that it further comprises at least the following steps:
   - subjecting a second portion of said durum wheat grain to a slight decortication (103), intended to partially remove the outer woody fraction of the pericarp of the durum wheat kernels;
   - grinding the decorticated grain (105), thus obtaining a coarse meal;
   - mixing the obtained coarse meal with said durum wheat flour (109), thus obtaining an integrated flour;
   - subjecting the obtained integrated flour to a pasta-making process (113), thus obtaining an edible pasta.

2. Process according to claim 1, wherein said coarse meal is subjected to a separation step (107), in order to obtain two or more fractions having a homogeneous particle size, and wherein only one of said fractions is mixed with said durum wheat flour in said mixing step (109).

3. Process according to claim 1 or 2, wherein said integrated flour is subjected to a sieving step (111) before undergoing said pasta-making step (113).

4. Process according to claim 1, wherein said decorticated grain is ground by micronization.

5. Process according to claim 2, wherein said coarse meal is separated into two or more fractions by turboseparation.

6. Process according to claim 3, wherein said sieving step is carried out by using a 1 mm mesh sieve.

7. Process according to any of the preceding claims,
wherein in said mixing step (109) said durum wheat flour represents 75 - 50% by weight of said integrated flour and said coarse meal represents 25 - 50% by weight of said integrated flour.

8. Edible pasta, more particularly durum wheat edible pasta, characterized in that it is produced by a process according to any of the claims 1 to 7.

9. Edible pasta according to claim 8, wherein the content of total arabinoxylans is greater than 2.15% DM (dry matter).

10. Edible pasta according to claim 8 or 9, wherein the content of alkylresorcinols is greater than 125.0 μg/g DM (dry matter).
PROVIDING A CERTAIN AMOUNT OF DURUM WHEAT GRAIN

SUBJECTING A FIRST PORTION THEREOF TO GRINDING AND BOLTING

SUBJECTING A SECOND PORTION THEREOF TO A SLIGHT DECORTICATION

SUBJECTING TO GRINDING

SUBJECTING TO SEPARATION

MIXING

SUBJECTING TO SIEVING

SUBJECTING TO A PASTA-MAKING PROCESS

FIGURE
**A. CLASSIFICATION OF SUBJECT MATTER**

INV. A23L1/10 A23L1/16 B02B1/00 B02C9/00

**ADD.**

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

A23L B02B B02C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
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<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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- **Further documents are listed in the continuation of Box C.**
- **X** See patent family annex.

* Special categories of cited documents:

- **"A"** document defining the general state of the art which is not considered to be of particular relevance
- **"E"** earlier application or patent but published on or after the international filing date
- **"L"** document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- **"O"** document referring to an oral disclosure, use, exhibition or other means
- **"P"** document published prior to the international filing date but later than the priority date claimed
- "**"T"** later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "**"X"** document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "**"Y"** document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "**"&"** document member of the same patent family

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Authorized officer: Vernier, Frédéric
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