(19) Octrooicentrum Nederland

(11) 2014888

(12) B1 OCTROOI

(21) Aanvraagnummer: **2014888**

(22) Aanvraag ingediend: **29/05/2015**

(51) Int. Cl.:
A23L 1/025 (2006.01)

(43) Aanvraag gepubliceerd:
24/01/2017

(47) Octrooi verleend:
31/01/2017

(45) Octrooischrift uitgegeven:
21/03/2017

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(54) **A method for increasing the nutritional value of vegetable materials and to a vegetable material obtained therewith.**

(57) The present invention relates to a method for increasing the nutritional value of a vegetable material by subjection of a vegetable material to heating by means of radiation in the radio frequency range, preferably the vegetable material is selected from grains, tubers and residual vegetable materials and one or more combinations thereof. The present invention is moreover related to a vegetable material having an improved nutritional value obtainable by a method according to the invention and to the use of the vegetable material as a feed for animals, preferably for ruminants or for preparing a mixed feed for animals, preferably ruminants.

NL B1 2014888

A method for increasing the nutritional value of vegetable materials and to a vegetable material obtained therewith.

Description

The present invention relates to a method for increasing the nutritional value of a vegetable material. In other words, the present invention relates to a method of treating a vegetable material to obtain a vegetable material having an increased nutritional value. Moreover, the present invention is related to a vegetable material obtained therewith. The method according to the present invention is mainly related to increasing the protein and /or the starch utilization of the material.

Methods for increasing the utilization of proteins in proteinaceous animal feed by ruminants are disclosed by prior art documents. These methods include: (a) chemical treatment with tannin, as disclosed in US patent No. 3,507,662, (b) chemical treatment with formaldehyde, as disclosed in US patent No. 3,619,200, (c) adding sugars to the proteinaceous animal feed and heating the mixture at a determined temperature and pH conditions, as disclosed in US patent No. 5,023,091, (d) mixing the proteinaceous animal feed with a carbohydrase enzyme, followed by heating of the mixture at a determined temperature, pH and percentage moisture; (e) heating the proteinaceous animal feed using compressive pressures, i.e. heating de product by frictional heat, for increasing the utilization of proteins by reducing the degradability of said materials as disclosed in US 3,695,891; (f) microwave radiation as discussed in Dong. S. et al, Asian Australas. J. Anim. Sci. 18, 2005, 27-31; Sadeghi A. et al, Anim. Sci. 80, 2005, 369-375; Brodie G. et.al, J. Microwave Power E. E. 46, 2012, 57-67.

The methods (a)-(d) all involve the reaction of the proteinaceous animal feed with an added reagent. Method (e) has the disadvantage that there is a risk of excessive heating leading to protein in the feed that is indigestible in the post-rumen tract. Method (f) has the disadvantage that the heating is not homogeneous and only the outer layer of the treatment material is heated leading to large inhomogeneous products and leads to a drawback that this method is not applicable on large scale since the heat has to penetrate the remainder of the product by means of convection and/or conduction.

Methods for increasing the utilization of starch in starch-containing animal feed by ruminants are disclosed by prior art documents: Dong. S. et al, Asian Australas. J. Anim. Sci. 18, 2005, 27-31; Sadeghi A. et al, Anim. Sci. 80, 2005, 369-375 and Brodie G. et.al, J. Microwave Power E. E. 46, 2012, 57-67, for example, showed that starch and protein digestibility is increased by heating animal fodder by means of microwaves, at a frequency of 2.45 GHz and a power ranging between 750 W and 6 kW.

There is a need in the field of feed preparation for an efficient, safe and reliable method for treating a vegetable material in order to increase the nutritional value and to increase the value of said material in feed manufacture.

It is an object of the present invention to provide a method for increasing the nutritional value of vegetable material which is suitable for use as or for being processed into animal feed.

It is another object of the present invention to provide a method for increasing the nutritional value of vegetable material in which only direct heating is used.

It is another object of the present invention to provide a method for increasing the nutritional value of vegetable material without the need to use chemical reagents.

A further object of the present invention is to provide a method for increasing the nutritional value of a vegetable material which is suitable for use as or for being processed into feed for ruminants.

One or more of the above cited objects are achieved by the several aspects and embodiments of the present invention as discussed below.

Summary of the invention

In a first aspect, the present invention relates to a method for increasing the nutritional value of a vegetable material. In other words, the present invention relates to a method of treating a vegetable material to obtain a vegetable material having an increased nutritional value.

The key to the present invention is to increase the nutritional value of a vegetable material by using heating by means of radiation in the radio frequency range (also called RF heating in the present invention).

The invention relates to a method for increasing the nutritional value of a vegetable material by subjection of a vegetable material to heating by means of radiation in the radio frequency range.

In an embodiment, the range of radio frequency radiation is an ISM radio band, preferably a frequency between 10 MHz and 50 MHz, preferably 27.12 MHz ±0.6 %.

In an embodiment, the vegetable material is selected from grains, tubers and residual vegetable materials and one or more combinations thereof.

In an embodiment, the residual vegetable material is a residue of grain or tuber processing. In an embodiment, the residual vegetable material is a residue of processing of rapeseed, soybean or sunflower seed or a combination thereof. In an embodiment, the residual vegetable material is selected from the group consisting of rapeseed meal, soybean meal, sunflower seed meal and one or more combinations thereof.

In an embodiment, the grains are selected from the group consisting of cereal grains, legumes and oilseeds, more preferably corn, soybeans, rapeseed, wheat, and one or more combinations thereof.

In an embodiment, the tubers are selected from the group consisting of potato, yam, sweet potato, cassava and one or more combinations thereof.

In an embodiment, the material is subjected to RF radiation to achieve a temperature of the material to be treated of between 85°C and 180°C, preferably between 110°C and 165°C, more preferably between 130°C and 150°C.

In an embodiment, soybean meal, extracted is used as vegetable material and wherein the Aufrère value has increased with 20 to 30 percentage units.

In an embodiment, rapeseed meal, extracted is used as vegetable material and wherein the Aufrère value has increased with 5 to 10 or even to 15 percentage units or wherein rapeseed meal, expeller is used as vegetable material and wherein the Aufrère value has increased with 25 to 45, preferably 30 to 35 percentage units.

In an embodiment, soybeans are used as vegetable material and wherein the Aufrère value has increased with 30 to 55 percentage units.

In an embodiment, corn is used as vegetable material and wherein the Aufrère value has increased with 15 to 35 percentage units.

In an embodiment, wheat is used as vegetable material and wherein the Aufrère value has increased with 5 to 25, preferably 10 to 15 percentage units.

The present invention also relates to a vegetable material having an improved nutritional value obtainable by a method according to the present invention. All embodiments specified for the method are also applicable for this product, unless otherwise specified.

The present invention also relates to the use of the vegetable material according to the present invention as a feed for animals, preferably for ruminants or for preparing a mixed feed for animals, preferably ruminants.

Definitions

The following definitions are used in the present description.

"Residual vegetable material" as used in the present application means: a material that remains after a raw vegetable material has been processed for obtaining one or more primary products; for example: a residue after processing of grains or tubers; or a residue after use of vegetable materials for obtaining biofuels, such as the so-called dried distillers grains and solubles (DDGS).

"Meal" as used in the present application means: the residual vegetable material that remains after processing of grains. It is a by-product obtained after either chemical extraction of oil (extracted meal) or after pressing to obtain oil (expelled meal or expeller meal). Meal according to the present invention includes both extracted meal or expelled meal.

“Radio frequency treatment” or “RF treatment” or “RF heating” as used in the present application means: subjecting a material to an alternating electromagnetic field of RF radiation. With radio frequency treatment the polarity of the electric field is changed several million times per second. This quick reversal (mechanical movement) of molecules will generate heat (thermal energy).

“Indirect heating” as used in the present application means: a heating method in which heat is generated externally to a material and is then transferred to its external surface by conduction, convection and/or radiation.

“Direct heating” as used in the present application means: a heating method in which heat is generated within a material itself, such as radio frequency (RF) heating.

“rumen resistant protein fraction” or “rumen resistant fraction“ as used in the present application means: the fraction of the feed material that passes the rumen without being degraded. This is sometimes also called rumen undegraded protein fraction.

“in situ nylon bag technique”: is the standard technique used for measuring the degradation of materials in the rumen and/or the intestines. In this technique nylon bags filled with a material are introduced into the rumen and/or the intestines of cows.

Detailed description of the invention

Radio frequency

RF radiation has working frequencies in the range of tens of megahertz. The frequency most commonly used in industrial equipment is about 27 MHz, corresponding to a wavelength of about 11 m; however a frequency of about 13 MHz is also often used. Radio frequencies can be used to endogenously heat a large volume of a product, viz. layers in the range of a meter. On the contrary, microwaves can penetrate only small layers, in the range of centimeters.

By using radio frequency, the energy for the required treatment is applied by a couple of electrodes, whose geometry is designed and set according to the product shape and size, receiving such energy from the generator. The electrodes are in fact the opposite plates of a capacitor and the product between them is the dielectric which, depending on its physical-chemical characteristics, absorbs the energy evenly and diffusely, notwithstanding its shape and size. Radio frequency treatment is a direct heating method.

The present invention typically uses RF that are in the so-called industrial, scientific and medical (ISM) radio bands (portions of the radio spectrum) which are reserved internationally for industrial, scientific and medical purposes other than telecommunications. The ISM bands are defined by the ITU-R in 5.138, 5.150, and 5.280 of the Radio Regulations. In an embodiment of the present method, the range of radio frequency radiation (radio waves) is between 1 MHz and 1000 MHz, preferably between 10 MHz and 100 MHz or between 10 MHz and 50 MHz. In one specific embodiment, the RF is 27.12 MHz ±0.6 % (between 26.957 MHz and 27.283 MHz). In another specific embodiment, the RF is 13.56 MHz ±0.05 % (between 13.553 MHz and 13.567 MHz). In another specific embodiment, the RF is 40.68 MHz ±0.05 % (between 40.66 MHz and 40.7 MHz).

It should be noted that typically an apparatus is set to one specific radio frequency with a certain variation range. The used working frequency depends on the regulations of each country as shown above. For the Netherlands, in 2015, the allowed radio frequency is set to 27.12 MHz ±0.6 %.

In an embodiment, the vegetable starting material is heated by means of said radiation to a final temperature of between 85°C and 180°C, preferably between 110°C and 165°C, more preferably between 130°C and 150°C. These temperatures are reached after radiation is applied to the material which increases the temperature of the material. The radiation is applied in such a manner that the final temperature that the material reaches is the temperature specified above. The temperature is measured using known means, e.g. a thermocouple at one or more locations in the material during irradiation.

The duration of the RF treatment (processing time) depends on the equipment used and may be determined by a person skilled in the art. The duration was found by the present inventor to have no real effect on the results. As a non-limiting example, the duration of the irradiation is between 5 minutes and 1.5 hours, such as between 20 minutes and 35 minutes. However, based on the settings and efficiency of the apparatus used, the intensity of the radiation, the amount of material irradiated and other factors, a person skilled in the art may be able to determine an optimal duration based on the final temperature desired. The power or intensity of the radiation may also vary and is partly dependent on the efficiency of the apparatus used. It may for example be between 0.1 and 0.2 kWh/kg starting material.

<u>Vegetable materials for use as starting material</u>

The vegetable material used in the method according to the present invention is preferably selected from grains, tubers and residual vegetable materials and one or more combinations thereof. It should be noted that “grains” also include “seeds” as discussed below in the section regarding grains.

Grains as starting material

Grains may be used as starting material for the present method. In other words, grains may be subjected to a radiation treatment using RF radiation.

In an embodiment, the grains are selected from the group consisting of cereal grains, legumes and oilseeds.

In an embodiment, the cereal grains may be selected from the group consisting of barley, oats, rice, rye, teff, triticale, wheat, corn, sorghum, and millet. Other cereal grains known in the art may also be used.

In an embodiment, the legumes (also called pulses) may be selected from the group consisting of soybeans, lupines, fava beans, peas, chickpeas, common beans, and lentils. Other legumes known in the art may also be used. These may be used as such or in the form of granulates, flakes, ground legumes etc.

In an embodiment, oilseeds may be selected from the group consisting of rapeseed (including canola), safflower seed, sunflower seed, flax seed (also called lin seed). Other oilseeds known in the art may also be used.

In an embodiment, the grains according to the present invention that are subjected to RF radiation are selected from the group consisting of: corn (preferably in the form of kernels), soybeans, rapeseed, wheat (preferably in the form of kernels), and one or more combinations thereof.

Tubers as starting material

In another embodiment, tubers may be used as starting materials, examples of stem tubers such as potatoes and yams, and root tubers, such as sweet potato, cassava and combinations thereof.

Residual vegetable material as starting material

Residual vegetable material may be used as starting material for the present method. In other words, residual vegetable materials may be subjected to a radiation treatment using RF radiation.

In an embodiment, the residual vegetable material is residue of grain processing, preferably a residue of processing of rapeseed, soybeans, wheat or corn and one or more combinations thereof, more preferably rapeseed meal, soybean meal, sunflower seed meal and one or more combinations thereof.

In another embodiment, the residual vegetable material is a residue of tuber processing, preferably a residue of processing potatoes, yams, sweet potato, cassava (to obtain tapioca), and combinations thereof.

In another embodiment the residual vegetable materials comprises residue after use of vegetable materials for obtaining biofuels.

<u>Nutritional value of vegetable materials</u>

The vegetable materials used as starting materials in the method according to the present invention have varying compositions. Some materials, for example most residual materials, have a relatively high protein content and very little starch.

Nutritional value of protein-containing materials

The present invention relates to the improvement of the nutritional value of vegetable materials, e.g. comprising proteins. Vegetable materials that are considered to be protein-containing are grains and residual material. The protein content of these starting materials may vary between 6 and 50 wt.% based on dry matter for grains and between 10 and 90 wt.% based on dry matter for residual materials. However, starting materials having other protein contents may also be used. The protein content of the starting material is not limiting for the present invention.

Typically, the method according to the present invention does not alter the total protein content of the product. Due to the heating water will evaporate so the protein content is determined on dry matter base (also called based on the dry fraction of the product).

The RF treatment method according to the present invention has an effect on increasing the nutritional value for example by decreasing the protein solubility and by increasing the protein fraction that is resistant to microbial degradation in the rumen; therefore passing to the small intestine and thus increasing the uptake thereof and the effective use of these nutrients.

In order to have a good estimate of the resistance to microbial degradation in the rumen of a ruminant, an in vitro protein rumen degradation test (also called Aufrère test) is carried out to determine the fraction of rumen undegraded protein (RUP). With Aufrère value according to the present invention is meant the percentage of rumen undegraded protein.

Untreated soybean meal, extracted typically has an Aufrère value of between 40 and 53 %. It is desired to obtain an Aufrère value of between 60 and 70 % after the treatment of the present invention. An increase of 10 to 30 percentage units, preferably between 20 and 30 percentage units is desired for this starting material.

Untreated rapeseed meal, extracted typically has an Aufrère value of between 60 and 65%. It is desired to obtain an Aufrère value of between 70 and 75% after the treatment of the present invention. An increase of 5 to 10 or even to 15 percentage units is desired for this starting material.

Untreated rapeseed meal, expeller typically has an Aufrère value of between 20 and 35%. It is desired to obtain an Aufrère value of between 60 and 65% after the treatment of the present invention. An increase of between 25 and 45, such as between 30 and 35 percentage units is desired for this starting material.

Untreated soybeans typically have an Aufrère value of between 10 and 20 %. It is desired to obtain an Aufrère value of between 50 % and 65 % after the treatment of the present invention. An increase of 30 to 55 percentage units is desired for this starting material.

Untreated corn typically has an Aufrère value of between 45 to 50 %. It is desired to obtain an Aufrère value of between 65 % and 80 % after the treatment of the present invention. An increase of 15 to 35 percentage units is desired for this starting material.

Untreated wheat typically has an Aufrère value of between 45 and 55 %. It is desired to obtain an Aufrère value of between 60 % and 70% after the treatment of the present invention. An increase of 5 (or 10) to 15 (or even 25) percentage units is desired for this starting material.

The nutritional value may be determined by comparing the values of e.g. digestible protein on the starting material and on the product. The values of digestible protein or intestinal digestible protein (IDP) are estimated based on rumen resistance fraction (estimated by Aufrère or *in situ* measurement); digestibility of the rumen resistant fraction in the small intestine (estimated by AIDP: available intestinal digestible protein); and losses.

The digestibility of the feed in the intestines which is directly related to the uptake of nutrients by the animal is determined by determining the amount of protein that is digested in the intestines according to the AIDP test. The AIPD might also be called “dRUP” being the digestible fraction of the RUP. The AIPD value is the percentage of protein that is taken up (digested) in the intestines. The AIPD value is as high as possible. However, the values for AIDP (being a percentage) depend on the starting material. When a very high protein starting material (e.g. soybeans or soybean meal) is used the desired AIDP values are much higher that when a lower protein starting material (e.g. rapeseeds or rapeseed meal) is used.

It is known that when a protein-containing material is heated, this may lead to a degradation of lysine. Using the method according to the present invention, the lysine content of the vegetable material may decrease depending upon the final heating temperature. Lysine is generally considered to one of the most important amino acid for ruminants; therefore it is preferred to limit the decrease of lysine content.

The higher the temperature used (within a certain range as specified above), the larger the effect on increasing the nutritional value of the protein but also the larger the decrease of lysine. This leads to a simultaneous decrease in the nutritional value of the material. However, it was surprisingly by the present inventor that the overall nutritional value still increased due to the increased due to the increase RUP. The present inventor have observed that there should be a balance between the RUP value and the lysine content by carefully selecting the final temperature.

In an embodiment, when the final temperature is 130 °C the lysine is preferably decreased with no more than 20 %, preferably no more than 15 %, more preferably no more than 7.5 %. In an embodiment, when the final temperature is 150 °C the lysine is preferably decreased with no more than 35 %, preferably no more than 30 %, more preferably no more than 20 %. With “is decreased” is meant a decrease resulting from the RF treatment calculated by comparing the value before and after the treatment. The lysine content may decrease as long as the overall nutritional value is increased.

Increasing nutritional value of starch-containing materials

In addition to feed ingredients comprising protein several feed materials also comprise starch. It was surprisingly found by the present inventor that the RF heating also has a beneficial effect on starch. It is therefore also an aspect of the present invention to use RF heating for increasing the starch nutritional value of vegetable materials.

Vegetable materials that are considered to be protein- and starch-containing are the following: cereal grains, most legumes, tubers and residues thereof. The protein content of these materials may vary between 8 and 70 wt.% based on dry matter. The starch content of these starting materials may vary between 12 and 80 wt.% based on dry matter. However, starting materials having other starch and/or contents may also be used. The starch and/or protein content of the starting material is not limiting for the present invention.

Typically, the method according to the present invention does not alter the total protein and/or starch content of the product. Due to the heating water will evaporate so the protein and/or starch content is determined on dry matter base.

In most Dutch feed evaluation systems the value of dietary starch is increased when more starch escapes degradation in the rumen and is enzymatically digested in the small intestine. Starch is hydrolyzed into glucose molecules and these are absorbed in the small intestines and serve as glucogenic nutrients generally leading to a more efficient milk (protein) production. It would therefore be beneficial if the rumen undegradable starch (RUS) fraction is increased without detrimental effects on starch digestion in the hind gut.

In an embodiment, for wheat the starting material typically has a RUS value of between 5 and 15 %. It is desired to achieve a RUS value after the RF treatment of between 25 and 55 %. An increase of 10 to 50 percentage units is desired.

In an embodiment, for corn the starting material typically has a RUS value of between 45 and 55 %. It is desired to achieve a RUS value after the RF treatment of between 60 and 75 %. An increase of 5 to 30 percentage units is desired.

Analyses

Chemical analyses

Several chemical analyses have been carried out in laboratories in order to provide information about the starting materials as well as the products. These techniques will be discussed in more detail below.

Moisture content: this relates to the amount of water. There is a difference in the moisture content of the starting material and the product since due to the heating water is evaporated. The moisture content of the starting material depends on the type and source of the starting material. The moisture content is determined using the method according to the EU Regulation (EC) No. 152/2009, Annex III, L54/12-14 (2009).

Crude protein content: The protein content is determined using the so-called crude protein method (N x 6.25). The protein content may be determined for both the starting material and/or the product. The determination is done based on the assumption that proteins contain 16 percent Nitrogen. The analysis is carried out using the method described in the EU Regulation (EC) No. 152/2009, Annex III, L54/15-19 (2009).

Starch content: the starch content is determined using ISO 15914:2004 “Enzymatic determination of total starch content”. The starch content may be determined for both the starting material and/or the product.

Lysine content (g/kg) is determined according to the total amino acid method disclosed in ISO13903 (2005).

In vitro analyses

Several in vitro analyses have been carried out in laboratories in order to give an estimate of the increase in the nutritional value of the RF treated vegetable materials according to the invention. These techniques simulate the behavior of nutrients in the animal and they will be discussed in more detail below.

in vitro protein rumen degradation: This relates to rumen undegraded protein (RUP). The Aufrère test is used, which is a standardized enzymatic laboratory technique to determine protein degradability in order to evaluate and predict the rumen degradability of various protein sources (Aufrère and Cartailler, 1988; Aufrère et al., 1991; Cone et al., 1996). In the present invention the Aufrère method used as specified here:

This test is based on the measurement of protein hydrolysis. Samples are hydrolyzed with a protease in a basic buffer. A borate-phosphate buffer (pH 8.0) is prepared using 21.6 g of sodium dihydrogen phosphate and 17.8 g of sodium tetraborate dissolved in 1.5 L of water wherein the pH is adjusted using 4M NaOH. A 10 mg/ml tetracycline solution in said buffer is prepared. A solution of 12.3 mg of protease (of Streptomyces griseus), 10 mg of nystatin suspended in a small amount of the borate-phosphate buffer, 10 ml of the tetracycline solution are mixed with buffer to reach 1 liter. The enzyme-solution should be brought to 40°C and approx. 500 mg of the sample to be measured is precisely weighted in a glass container and 50 ml of the enzyme-solution is added. As a blank only the enzyme-solution without sample is taken. The samples are incubated for a period of 24 hours at 40 °C in a water bath. The sample is mildly agitated at 1, 6 and 23 hours during 4 minutes at 60 rpm. The glass containing with sample is carefully transferred to an ice bath for 10 minutes and then the sample is filtered over a paper filter. Of the filtrate 25 ml is taken and two Kjeldahl C tablets (5 g K_2SO_4 + 0.1 g $CuSO_45H_2O$) and 20 ml of 96 % sulfuric acid is added to destruct the amino acids. This is heated/evaporated at 150 °C during 1 night. The amount of remaining nitrogen in the sample is determined using the Kjeldahl method using a Kjeltec 2400KT off Foss according to EU Regulation (EC) No. 152/2009, Annex III, L54/15-19 (2009). To calibrate for a specific batch or protease used a sample having a known amount of nitrogen should be tested.

In situ (in sacco) analyses

In situ analyses have been carried out in animals by specialized institutes.

<u>*In situ* rumen protein degradation</u>: the amount of protein that is degraded, after subjecting a sample of a material to the *in situ protein degradation* test, measured according to the Dutch 2003 Protocol for In Situ Rumen Incubations: Determination of Degradation Rate and Washable Fractions of Protein, Starch, Cell Walls and Organic Residual Fraction (Dutch: Protocol voor in situ pensincubatie: bepaling van afbraaksnelheid en uitwasbare fracties van eiwit, zetmeel, celwanden en organische restfractie; 10 december 2003, Centraal Veervoer Buro, Lelystad, pages 1-14). The amount of protein that does not degrade in this test is defined as the resistant protein. A in situ nylon bag technique is used for this method. Test cows having a rumen cannula were used. At least 5 different incubation times in the rumen were used; 20 to 35 nylon bags were incubated per cow. After incubation in the rumen, the material containing nylon bags were brought into ice water; followed by freezing. Subsequently, the frozen bags were washed using a standard washing machine with water at room temperature, without centrifugation. After washing the material containing nylon bags were dried. Several of these bags where subjected to freeze-drying, pooling per animal and grinding through 1 mm, the residues were analyzed for crude protein content. The remainder of the bags were used for the AIDP test.

<u>In situ intestinal digestibility (AIDP)</u>: this is the amount of protein that is digested in the intestines. The in situ nylon bag technique was used and as a starting point nylon bags were used that have undergone the in situ rumen protein degradation test and subsequent

acid treatment to resemble passage through the abomasum. The present in situ study provides valuable information about the amount of protein that is being taken up in the intestines; an increase in this value means an increase in the nutritional value of the feed material. The AIDP is expressed in a percentage (%) of the feed sample is estimated using the method disclosed in Animal (2014), 8:11, pp 1839–1850: “The energy and protein value of wheat, maize and blend DDGS for cattle and evaluation of predicting methods” by J. L. De Boever, M. C. Blok, S. Millet, J. Vanacker and S. De Campeneere. It is calculated per cow according to the equation below:

$$\frac{(In(gram) * CPC) - (Out(gram) * CPC)}{In(gram) * CPC}$$

Wherein “In(gram)” is the sum of all the weighed rumen residues, being the contents of the mobile nylon bags that remained after the in situ rumen protein degradation test (16 h) in grams. Wherein the CPC stands for crude protein content and is the fraction of the total weight that is protein (e.g. a protein content of 16% gives a CPC of 0.16). Wherein “out(gram) is the sum of all the weighed intestinal residues, being the contents of the mobile nylon bags that remained after the in situ intestinal digestibility test in grams. Cows having a T-cannula in the upper part of the duodenum were used. The nylon bags obtained from the rumen test were used; 10 bags were incubated per cow. Immediately before insertion in the duodenum, bags were soaked in a pepsin-0.1 N HCl-solution at 39 °C to simulate digestion in the abomasum. Every 20 min four bags were incubated in the duodenum. After passage through the intestines, bags were almost directly recuperated from the feces, rinsed and frozen. After thawing, they were intensively machine-washed at least four times using water at 40°C and finally spinning at 700 rpm. After freeze-drying, pooling per animal and grinding through 1 mm, the residues were analyzed for crude protein content.

<u>**Use of product**</u>

The present invention relates to a method for increasing the nutritional value, preferably protein and/or starch value, of a vegetable material by treating the starting material with RF heating.

The vegetable material that is treated according to the method of the present invention, the product, may be used as a feed for animals. More preferably, the product is used as a feed for ruminants. The feed according to the present invention has an increased nutritional value for ruminants, especially a better resistance to the rumen and due to a shift of digestion from the rumen to the intestines it increases the utilization of protein and starch. As non-limiting examples of ruminants are mentioned dairy cows, beef cattle, goats, and sheep.

Examples

As specified above, the present invention is related to a method for increasing the nutritional value of a protein-containing residual vegetable material. In order to increase the nutritional value of said protein-containing residual vegetable material, said material is heated by means of radiation in the radio frequency range.

In the examples 1-10, two kilograms of a vegetable material were subjected to radiation in the radio frequency range, at a frequency of 27.12 MHz. The maximum temperature to which samples were heated to is the ‘Final Temperature’ (T_f). Example 1 uses soybean meal, extracted. Example 2 uses rapeseed meal, extracted. Example 3 uses soybean meal, expeller. Example 4 uses rapeseed meal, expeller. Example 5 uses soybeans. Example 6 uses rapeseeds. Example 7 uses ground corn kernels, Example 8 uses whole corn kernels. Example 9 uses ground wheat and Example 10 uses whole wheat. For each of these examples the crude protein and Aufrère value were determined prior to the heating (*) and at the four different final temperatures: 90 °C (a); 110 °C (b); 130 °C (c); and 150 °C (d).

The amount of crude protein CP (amount of protein in gram per kilogram of material) is measured based on dry matter of the material. The in vitro protein degradation resistance is given in % as measured according to the Aufrère method. The results are shown in Table 1, in which examples with an asterisk are samples that were not subjected to the heating treatment, viz. they are used as reference.

Table 1

Example	Material	T_f (°C)	CP dry (g/kg)	Aufrère (%)
1*	Soybean meal, extracted	-	510	41.8
1a	Soybean meal, extracted	90	510	39.1
1b	Soybean meal, extracted	110	512	43.4
1c	Soybean meal, extracted	130	509	61.1
1d	Soybean meal, extracted	150	513	70.3
2*	Rapeseed meal, extracted	-	390	65.1
2a	Rapeseed meal, extracted	90	392	63.7
2b	Rapeseed meal, extracted	110	389	64.6
2c	Rapeseed meal, extracted	130	392	67.6
2d	Rapeseed meal, extracted	150	391	76.3
3*	Soybean meal, expeller	-	448	53.9
3a	Soybean meal, expeller	90	446	60.3
3b	Soybean meal, expeller	110	446	60.6
3c	Soybean meal, expeller	130	447	64.5
3d	Soybean meal, expeller	150	445	65.3
4*	Rapeseed meal, expeller	-	379	23.9
4a	Rapeseed meal, expeller	90	381	23
4b	Rapeseed meal, expeller	110	379	29.9
4c	Rapeseed meal, expeller	130	381	34.7
4d	Rapeseed meal, expeller	150	379	61.6
5*	Soybean	-	396	11.5
5a	Soybean	90	399	35.9
5b	Soybean	110	400	44.5
5c	Soybean	130	404	50.8
5d	Soybean	150	400	58.1
6*	Rapeseed	-	210	34.5
6a	Rapeseed	90	211	32.4
6b	Rapeseed	110	211	33
6c	Rapeseed	130	211	39.4
6d	Rapeseed	150	210	59.2
7*	Corn Ground	-	80	72.7

7a	Corn Ground	90	83	76.2
7b	Corn Ground	110	83	76.5
7c	Corn Ground	130	82	79.9
7d	Corn Ground	150	81	84.0
8*	Corn Whole	-	81	70.2
8a	Corn Whole	90	82	75.8
8b	Corn Whole	110	82	78.0
8c	Corn Whole	130	83	81.2
8d	Corn Whole	150	82	82.5
9*	Wheat Ground	-	137	54.0
9a	Wheat Ground	90	137	60.3
9b	Wheat Ground	110	137	60.0
9c	Wheat Ground	130	134	62.0
9d	Wheat Ground	150	136	67.5
10*	Wheat Whole	-	138	48.9
10a	Wheat Whole	90	139	46.1
10b	Wheat Whole	110	137	47.6
10c	Wheat Whole	130	137	56.1
10d	Wheat Whole	150	138	59.4

From Table 1 it is clear that for soybean meal, extracted (Example 1) the Aufrère value increases from 41.8 to 70.3 upon heating to a final temperature of 150 °C. When the final temperature was 90 or 110 °C there was hardly any increase. The crude protein content hardly decreases.

From Table 1 it is clear that for rapeseed meal, extracted (Example 2) the Aufrère value increases from 65.1 to 76.3 upon heating to a final temperature of 150 °C. When the final temperature was 90 or 110 °C there was hardly any increase. The crude protein content hardly decreases.

From Table 1 it is clear that for soybean meal, expeller (Example 3) the Aufrère value increases from 53.9 to 65.3 upon heating to a final temperature of 150 °C. When the final temperature was 90 or 110 °C there was a small increase to around 60%. The crude protein content hardly decreases.

From Table 1 it is clear that for rapeseed meal, expeller (Example 4) the Aufrère value increases from 23.9 to 61.6 upon heating to a final temperature of 150 °C. When the final temperature was 90 °C there was hardly any increase. The crude protein content hardly decreases.

From Table 1 it is clear that for soybeans (Example 5) the Aufrère value increases from 11.5 to 58.1 upon heating to a final temperature of 150 °C. When the final temperature was 90 °C there was also an increase to 35.9. The crude protein content hardly decreases.

From Table 1 it is clear that for rapeseeds (Example 6) the Aufrère value increases from 34.5 to 59.2 upon heating to a final temperature of 150 °C. When the final temperature was 90 °C or 110 °C or even 130 °C there was no or only a small increase. The crude protein content hardly decreases.

From Table 1 it is clear that for ground corn (Example 7) the Aufrère value increases from 72.7 to 84.0 upon heating to a final temperature of 150 °C. When the final temperature was 90 °C or 110 °C only a small increase was observed. The crude protein content hardly decreases.

From Table 1 it is clear that for whole corn kernels (Example 8) the Aufrère value increases from 70.2 to 82.5 upon heating to a final temperature of 150 °C. When the final temperature was 90 °C there was already an increase. The crude protein content hardly decreases.

From Table 1 it is clear that for ground wheat (Example 9) the Aufrère value increases from 54.0 to 67.5 upon heating to a final temperature of 150 °C. When the final temperature was 90 °C there was already an increase. The crude protein content hardly decreases.

From Table 1 it is clear that for whole wheat (Example 10) the Aufrère value increases from 48.9 to 59.4 upon heating to a final temperature of 150 °C. When the final temperature was 90 °C or 110 °C there was hardly any increase. T The crude protein content hardly decreases.

Hence, table 1 shows that when using the method according to the present invention the value for in vitro protein degradation resistance (Aufrère) increases, which means that the nutritional value is increased and hence one or more of the aims of the present invention are obtained. Moreover, with increasing final temperature the in vitro protein degradation resistance increases. This means that by increasing the final temperature the rumen resistant protein fraction increases, which indicates that the protein value of the protein increases, unless protein digestibility is decreased which is shown in Table 3 below.

In the following examples 1, 2, and 4, two kilograms of a vegetable material were subjected to radiation in the radio frequency range, at a frequency of 27.12 MHz. The maximum temperature to which samples were heated to is the 'Final Temperature' (T_f). Untreated example is denoted with (*) and a heat treated example to a final temperatures of 130 °C was denoted with (c); and a final temperature of 150 °C was denoted with (d).

Table 2 shows the determination of lysine (Lys) content of the samples shown in Table 1. Lysine content is expressed in grams of lysine per kilogram of sample (Lys), in grams of lysine per kilogram of dry sample (Lys dry), and as the percentage of Lysine in the crude protein (Lys % CP).

Table 2

Example	Lys (g/kg)	Lys dry (g/kg)	Lys % CP
1*	27.6	30.9	6.07
1c	28.5	29.8	5.86
1d	26.7	27.5	5.36
2*	19.1	21.4	5.49
2c	19.5	20.4	5.21
2d	17.2	17.6	4.50
4*	20.8	22.9	6.0
4c	20.9	21.8	5.7
4d	18.1	18.5	4.9

From Table 2 it is clear that the lysine content on dry matter decreases from 30.9 to 27.5 g/kg for Example 1 and from 21.4 to 17.6 for Example 2 and from 22.9 to 18.5 for Example 4. There is a slight decrease observed in the lysine content upon heating.

In the following examples 1`and 2` two kilograms of a vegetable material were subjected to radiation in the radio frequency range, at a frequency of 27.12 MHz. The maximum temperature to which samples were heated to is the ‘Final Temperature’ (T_f). Example 1` uses soybean meal, extracted. Example 2` uses rapeseed meal, extracted. Different batches have been used than for examples 1, 2, above. Therefore, small differences in the values may be present. Untreated example is denoted with (*) and heat treated examples are denoted as follows:

(e) = a final temperature of 85 °C with a holding time at that temperature of 0 minutes

(f) = a final temperature of 85 °C with a holding time at that temperature of 5 minutes

(g) = a final temperature of 85 °C with a holding time at that temperature of 10 minutes

(h) = a final temperature of 100 °C with a holding time at that temperature of 0 minutes

(i) = a final temperature of 100 °C with a holding time at that temperature of 5 minutes

(j) = a final temperature of 100 °C with a holding time at that temperature of 10 minutes

(k) = a final temperature of 115 °C with a holding time at that temperature of 0 minutes

(l) = a final temperature of 115 °C with a holding time at that temperature of 5 minutes

(m) = a final temperature of 115 °C with a holding time at that temperature of 10 minutes

(n) = a final temperature of 130 °C with a holding time at that temperature of 0 minutes

Table 3 shows the determination of crude protein (CP), in vitro protein degradation resistance (Aufrère), the protein fraction remaining undegraded after 16 hours incubation (RUP), Digestibility of rumen undegraded protein (%),when holding the final temperature for different times (time). The amount of crude protein CP (amount of protein in gram per kilogram of material) is measured based on dry matter of the material.

Table 3

Ex.	Material	T_f (°C)	Time (min)	CP (g/kg)	Aufrère (%)	RUP (%)	AIDP (%)
1`*	Soybean meal, extracted	-	-	558	51.2	44.2	99.0
1`e	Soybean meal, extracted	85	0	522	53.0	48.2	98.9
1`f	Soybean meal, extracted	85	5	533	54.4	48.7	99.0
1`g	Soybean meal, extracted	85	10	529	55.8	52.4	98.9
1`h	Soybean meal, extracted	100	0	525	54.1	49.2	99.0
1`i	Soybean meal, extracted	100	5	530	55.6	53.8	99.2
1`j	Soybean meal, extracted	100	10	535	55.1	52.9	99.1
1`k	Soybean meal, extracted	115	0	510	59.1	57.6	99.1
1`l	Soybean meal, extracted	115	5	511	63.2	59.4	99.2
1`m	Soybean meal, extracted	115	10	505	59.6	57.3	99.0
1`n	Soybean meal, extracted	130	0	497	70.0	67.8	99.2
2`*	Rapeseed meal, extracted	-	-	391	60.9	34.3	82.3
2`e	Rapeseed meal, extracted	85	0	391	60.7	33.7	82.8
2`f	Rapeseed meal, extracted	85	5	389	60.7	34.6	82.7
2`g	Rapeseed meal, extracted	85	10	390	60.6	36.8	84.6
2`h	Rapeseed meal, extracted	100	0	389	60.6	34.1	82.4
2`i	Rapeseed meal, extracted	100	5	390	60.3	34.5	82.8
2`j	Rapeseed meal, extracted	100	10	391	61.8	36.7	83.6
2`k	Rapeseed meal, extracted	115	0	389	61.1	39.1	84.1
2`l	Rapeseed meal, extracted	115	5	392	62.4	41.0	84.7
2`m	Rapeseed meal, extracted	115	10	387	62.1	40.5	84.9
2`n	Rapeseed meal, extracted	130	0	388	64.8	49.9	87.4

From Table 3 it is clear that there is no effect on the holding time. From Table 3 when comparing Example 1`* with Example 1`n and Example 2`* with Example 2`n the effect of a heat treatment at 130 °C is observed. For soybean meal the Aufrère value increases from 51.2 to 70.0 and for rapeseed meal from 60.9 to 64.8. For soybean meal the RUP value increases from 44.2 to 67.8 and for rapeseed meal from 34.3 to 49.9. For soybean meal the AIDP value increases from 99.0 to 99.2 and for rapeseed meal from 82.3 to 87.4. Hence it is clear from Table 3 that the present invention achieves one or more of the aims of the present invention.

In the following Examples 7-10 the effect on the starch as well as protein nutritional value is determined. In the examples 7-10, two kilograms of a vegetable material were subjected to radiation in the radio frequency range, at a frequency of 27.12 MHz. The maximum temperature to which samples were heated to is the 'Final Temperature' (T_f). Example 7 uses ground corn kernels, Example 8 uses whole corn kernels. Example 9 uses ground wheat and Example 10 uses whole wheat. For each of these examples the starch content, RUS, RUP and AIDP were determined prior to the heating (*) and at the four different final temperatures: 90 °C (a); 110 °C (b); 130 °C (c); and 150 °C (d). The determination of starch content (Starch) and protein content (protein) is given in grams per kilogram of dry sample. Table 4 moreover shows the starch fraction remaining undegraded after 6 hours incubation (RUS) and protein fraction remaining undegraded after 16 hours incubation (RUP), and digestibility of rumen undegraded protein (%).

Table 4

Example	T_f (°C)	Protein dry (g/kg)	Starch dry (g/kg)	RUS (%)	RUP (%)	AIDP(%)
7*	-	80	722	52.2	48.5	94.7
7a	90	83	727	54.4	53.1	94.8
7b	110	83	724	n.d.	n.d.	n.d.
7c	130	82	723	59.5	65.6	94.4
7d	150	81	726	68.9	75.9	93.0
8*	-	81	743	49.6	49.5	94.3
8a	90	82	727	54.5	55.6	95.0
8b	110	82	732	n.d.	n.d.	n.d.
8c	130	83	724	66.1	66.5	93.8
8d	150	82	731	67.5	72.4	91.2
9*	-	137	667	9.1	7.8	73.5
9a	90	137	654	7.0	9.1	78.3
9b	110	137	641	n.d.	n.d.	n.d.
9c	130	134	667	23.4	36.4	93.2
9d	150	136	667	43.9	58.6	92.2
10*	-	138	658	6.5	7.9	73.5
10a	90	139	664	10.3	9.5	78.3
10b	110	137	674	n.d.	n.d.	n.d.
10c	130	137	671	34.3	53.4	95.7
10d	150	138	669	46.0	63.6	94.8

From Table 4 it is clear that for ground corn (Example 7) the RUS value increases from 52.2 to 68.9 upon heating to a final temperature of 150 °C. The RUP value increases from 48.5 to 75.9 upon heating to a final temperature of 150 °C. The starch and protein content hardly changes.

From Table 4 it is clear that for whole kernel corn (Example 8) the RUS value increases from 49.6 to 67.5 upon heating to a final temperature of 150 °C. The RUP value increases from 49.5 to 72.4 upon heating to a final temperature of 150 °C. The starch and protein content hardly changes.

From Table 4 it is clear that for ground wheat (Example 9) the RUS value increases from 9.1 to 43.9 upon heating to a final temperature of 150 °C. The RUP value increases from 7.8 to 58.6 upon heating to a final temperature of 150 °C. The AIDP value increases. The starch and protein content hardly changes.

From Table 4 it is clear that for whole wheat (Example 10) the RUS value increases from 6.5 to 46.0 upon heating to a final temperature of 150 °C. The RUP value increases from 7.9 to 63.6 upon heating to a final temperature of 150 °C. The AIDP value increases. The starch and protein content hardly changes.

From the Examples it is clear that the method according to the present invention increases the nutritional value of the vegetable material that is treated and hence one or more objects of the present invention are achieved by the present method which is further elucidated in the appended claims.

CONCLUSIES

1. Werkwijze voor het verhogen van de voedingswaarde van een plantaardig materiaal door het blootstellen van een plantaardig materiaal aan verwarming door middel van straling in het radio frequentiegebied.

2. Werkwijze volgens conclusie 1, waarbij het gebied van radiofrequente straling een ISM radio band is, bij voorkeur een frequentie tussen 10 MHz en 50 MHz, bij voorkeur 27,12 MHz ± 0,6%.

3. Werkwijze volgens één of meer van de voorafgaande conclusies, waarbij het plantaardige materiaal wordt gekozen uit granen, knollen en residueel plantaardige materiaal en één of meer combinaties daarvan.

4. Werkwijze volgens één of meer van de voorafgaande conclusies, waarbij het residuele plantaardige materiaal een residu van graanverwerking is, bij voorkeur een residu van de verwerking van raapzaad, sojabonen, tarwe of maïs en één of meer combinaties daarvan, bij voorkeur raapzaadmeel, sojameel, zonnebloempitmeel en één of meer combinaties daarvan.

5. Werkwijze volgens een of meer van de conclusies 1-3, waarbij de granen worden gekozen uit de groep bestaande uit graankorrels, peulvruchten en oliezaden, bij voorkeur maïs, sojabonen, raapzaad, tarwe, en één of meer combinaties daarvan.

6. Werkwijze volgens een of meer van de conclusies 1-3, waarbij de knollen worden gekozen uit de groep bestaande uit aardappel, yam, zoete aardappel, cassave en één of meer combinaties daarvan.

7. Werkwijze volgens één van de voorafgaande conclusies, waarbij het materiaal wordt blootgesteld aan straling om een temperatuur te bereiken tussen 85 °C en 180 °C, bij voorkeur tussen 110 °C en 165 °C, meer bij voorkeur tussen 130 °C en 150 °C.

8. Plantaardig materiaal met een verbeterde voedingswaarde dat kan worden verkregen door een werkwijze volgens één of meer van de voorgaande conclusies.

9. Plantaardig materiaal volgens conclusie 8, waarbij sojabonenmeel, geëxtraheerd is gebruikt als plantaardig materiaal en waarbij de Aufrère waarde is verhoogd met 20-30 procent-eenheden.

10. Plantaardig materiaal volgens een of meer van de conclusies 8-9, waarbij raapzaadmeel, geëxtraheerd is gebruikt als plantaardig materiaal en waarbij de Aufrère waarde is verhoogd met 5 tot 10 of zelfs 15 procent-eenheden of waarbij raapzaadmeel, schilfers (expeller) is gebruikt als plantaardige materiaal en waarbij de Aufrère waarde is verhoogd met 25-45, bij voorkeur 30 tot 35 procent-eenheden.

11. Plantaardig materiaal volgens een of meer van de conclusies 8-10, waarbij sojabonen zijn gebruikt als plantaardig materiaal en waarbij de Aufrère waarde is verhoogd met 30 tot 55 procent-eenheden.

12. Plantaardig materiaal volgens een of meer van de conclusies 8-11, waarbij maïs is gebruikt als plantaardig materiaal en waarbij de Aufrère waarde is verhoogd met 15 tot 35 procent-eenheden.

13. Plantaardig materiaal volgens een of meer van de conclusies 8-12, waarbij tarwe is gebruikt als plantaardig materiaal en waarbij de Aufrère waarde is verhoogd met 5 tot 25, bij voorkeur 10 tot 15 procent-eenheden.

14. Gebruik van het plantaardige materiaal volgens een of meer van de conclusies 8-13 als veevoer, bij voorkeur voor herkauwers.

15. Gebruik van het plantaardige materiaal volgens een of meer van de conclusies 8-13 voor het bereiden van een gemengd voer voor dieren, bij voorkeur herkauwers.

ABSTRACT

The present invention relates to a method for increasing the nutritional value of a vegetable material by subjection of a vegetable material to heating by means of radiation in the radio frequency range, preferably the vegetable material is selected from grains, tubers and residual vegetable materials and one or more combinations thereof. The present invention is moreover related to a vegetable material having an improved nutritional value obtainable by a method according to the invention and to the use of the vegetable material as a feed for animals, preferably for ruminants or for preparing a mixed feed for animals, preferably ruminants.

Rijksdienst voor Ondernemend Nederland

RAPPORT BETREFFENDE HET ONDERZOEK NAAR DE STAND VAN DE TECHNIEK

Octrooiaanvrage 2014888

Classificatie van het onderwerp[1]: A23L1/025	Onderzochte gebieden van de techniek[1]: A23L
Computerbestanden: EPODOC, WPI, BIOSIS, MEDLINE, TCM, XPESP, EMBASE	Omvang van het onderzoek: Volledig
Datum van de onderzochte conclusies: 27 augustus 2015	Niet onderzochte conclusies:

Van belang zijnde literatuur

Categorie[2]	Vermelding van literatuur met aanduiding, voor zover nodig, van speciaal van belang zijnde tekstgedeelten of figuren.	Van belang voor conclusie(s) nr.:
X	R. Borchers & L.D. Manage "Rapid Improvement in Nutritional Quality of Soybeans by Dielectric Heating", Journal of Food Science, 1972, volume 37, pagina's 333-334 * het gehele document * – – –	1-15
X	T. Vearasilp et al. "Effect of Radio Frequency Technique on Nutrient Quality and Destruction of Trypsin Inhibitor in Soybean", Deutscher Tropentag, 11-13 oktober 2005, Hohenheim, "The Global Food & Product Chain—Dynamics, Innovations, Conflicts, Strategies" * het gehele document * – – –	1-15
A	Schuster-Gajzago Ildiko et al. "The effect of radio frequency heat treatment on nutritional and colloid-chemical properties of different white mustard (Sinapis alba L.) varieties", Innovative Food Science and Emerging Technologies, 2006, volume 7, pagina's 74-79 * het gehele document * – – –	
A	M. A. Faldet et al. "Determining optimal heat treatment of soybeans by measuring available lysine chemically and biologically with rats to maximize protein utilization by ruminants" Journal of nutrition, 1992, volume 122, nr. 1, pagina's 151-160 – – – – –	

Datum waarop het onderzoek werd voltooid: 18 januari 2016	De bevoegde ambtenaar: mw. dr. ing. L. Bechger **Octrooicentrum Nederland,** **onderdeel van Rijksdienst voor Ondernemend Nederland**

[1] Gedefinieerd volgens International Patent Classification (IPC).
[2] Verklaring van de categorie-aanduiding: zie apart blad.

<u>Categorie van de vermelde literatuur</u>:

X: op zichzelf van bijzonder belang zijnde stand van de techniek

Y: in samenhang met andere geciteerde literatuur van bijzonder belang zijnde stand van de techniek

A: niet tot de categorie X of Y behorende van belang zijnde stand van de techniek

O: verwijzend naar niet op schrift gestelde stand van de techniek

P: literatuur gepubliceerd tussen voorrangs- en indieningsdatum

T: niet tijdig gepubliceerde literatuur over theorie of principe ten grondslag liggend aan de uitvinding

E: octrooiliteratuur gepubliceerd op of na de indieningsdatum van de onderhavige aanvrage en waarvan de indieningsdatum of de voorrangsdatum ligt voor de indieningsdatum van de onderhavige aanvrage.

D: in de aanvrage genoemd

L: om andere redenen vermelde literatuur

&: lid van dezelfde octrooifamilie; corresponderende literatuur

Rijksdienst voor Ondernemend Nederland

SCHRIFTELIJKE OPINIE

Octrooiaanvrage 2014888

Indieningsdatum: 29 mei 2015	Voorrangsdatum:
Classificatie van het onderwerp[1]: A23L1/025	Aanvrager: Agrifirm Group B.V.

Deze schriftelijke opinie bevat een toelichting op de volgende onderdelen:

- ☑ Onderdeel I — Basis van de schriftelijke opinie
- ☐ Onderdeel II — Voorrang
- ☐ Onderdeel III — Vaststelling nieuwheid, inventiviteit en industriële toepasbaarheid niet mogelijk
- ☑ Onderdeel IV — De aanvraag heeft betrekking op meer dan één uitvinding
- ☑ Onderdeel V — Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid
- ☐ Onderdeel VI — Andere geciteerde documenten
- ☐ Onderdeel VII — Overige gebreken
- ☑ Onderdeel VIII — Overige opmerkingen

De bevoegde ambtenaar:

mw. dr. ing. L. Bechger

Octrooicentrum Nederland,

onderdeel van Rijksdienst voor Ondernemend Nederland

[1] Gedefinieerd volgens International Patent Classification (IPC).

Schriftelijke Opinie

Octrooiaanvrage **2014888**

Onderdeel I	**Basis van de schriftelijke opinie**

Deze schriftelijke opinie is opgesteld op basis van de op 27 augustus 2015 ingediende conclusies.

Onderdeel IV	**De aanvraag heeft betrekking op meer dan één uitvinding**

Vastgesteld is dat de octrooiaanvraag betrekking heeft op meer dan één uitvinding. Het onderzoek naar de stand van de techniek is beperkt tot de eerstgenoemde uitvinding in de conclusies en betreft:

☒ alle conclusies

☐ conclusies

Toelichting:

De zinsnede "dat kan worden verkregen door een werkwijze volgens één of meer van de voorgaande conclusies" in conclusie 8 suggereert dat het plantaardig materiaal met een verbeterde voedingswaarde niet perse via de werkwijze volgens conclusies 1 t/m 7 maar via elke andere (willekeurige) werkwijze voor het verhogen van de voedingswaarde kan worden verkregen.
Dientengevolge berusten de conclusies op twee verschillende uitvindingsgedachten. De twee uitvindingen zijn (kort gezegd):
- Conclusies 1-7, betreffende een werkwijze voor het verhogen van de voedingswaarde van een plantaardig materiaal middels verwarming door radiofrequente bestraling, en conclusies 8 t/m 13 voor zover deze betrekking hebben op het plantaardig materiaal met een verbeterde voedingswaarde verkregen door de werkwijze volgens conclusies 1 t/m 7, en conclusies 14 en 15 betreffende het gebruik van het plantaardig materiaal volgens conclusies 8 t/m 13, voor zover conclusies 8 t/m 13 betrekking hebben op het plantaardig materiaal met een verbeterde voedingswaarde verkregen door de werkwijze volgens conclusies 1 t/m 7.
- Conclusies 8 t/m 13, betreffende een plantaardig materiaal met een verbeterde voedingswaarde verkregen via elke willekeurige werkwijze, en conclusies 14 en 15 betreffende het gebruik van het plantaardig materiaal volgens deze conclusies 8 t/m 13.

Het onderzoek naar de stand van de techniek is beperkt tot de eerstgenoemde uitvinding.

Onderdeel V	**Gemotiveerde verklaring ten aanzien van nieuwheid, inventiviteit en industriële toepasbaarheid**

1. Verklaring

Nieuwheid	Ja	: Conclusie(s)	4, 6, 9-13
	Nee	: Conclusie(s)	1-3, 5, 7, 8, 14, 15
Inventiviteit	Ja	: Conclusie(s)	-
	Nee	: Conclusie(s)	4, 6, 9-13

Schriftelijke Opinie

Octrooiaanvrage **2014888**

Industriële toepasbaarheid	Ja : Conclusie(s)	1-15
	Nee : Conclusie(s)	-

2. Literatuur en toelichting

D1 = R. Borchers & L.D. Manage in Journal of Food Science, 1972

D2 = T. Vearasilp et al. in Deutscher Tropentag, 2005

D3 = Schuster-Gajzago Ildiko et al. in Innovative Food Science and Emerging Technologies, 2006

D4 = M. A. Faldet et al. in Journal of nutrition, 1992

D1 openbaart een werkwijze voor het verhogen van de voedingswaarde ("improvement of the nutritive value") van een plantaardig materiaal ("soybeans") door het blootstellen van een plantaardig materiaal aan verwarming door middel van straling in het radio frequentiegebied ("radiofrequency dielectric heating").
Conclusies 1, 3 en 5 zijn niet nieuw.
Het materiaal wordt blootgesteld aan straling om een temperatuur te bereiken tussen 127 °C tot 168 °C (zie tabel 1). Conclusie 7 is niet nieuw.

Nu de werkwijze volgens conclusie 1 niet nieuw wordt geacht is het daaruit rechtstreeks verkregen product, conclusie 8, dat evenmin.

D2 openbaart eveneens een werkwijze voor het verhogen van de voedingswaarde ("to destroy trypsin inhibitor in order to improve nutritive value") van een plantaardig materiaal ("soybean") door het blootstellen van een plantaardig materiaal aan verwarming door middel van straling in het radio frequentiegebied ("irradiated with radio frequency at 27.12 MHz"). Tenminste conclusies 1 t/m 3, 5 en 8 zijn niet nieuw in het licht van D2.
D2 vermeldt dat sojabonen een voorname bron van eiwitten is in veevoer. Conclusies 14 en 15 zijn (impliciet) ook niet nieuw.

De maatregelen van conclusies 4 en 6 zijn niet meer dan triviale alternatieven van conclusie 3 en berusten niet op uitvinderswerkzaamheid. Derhalve zijn D1 en D2 inventiviteitsbezwarend voor conclusies 4 en 6.

Conclusies 9 t/m 13 hebben betrekking op verschillende plantaardige materialen met verhoogde voedingswaarde verkregen door blootstelling aan verwarming door middel van straling in het radio frequentiegebied en een Aufrère waarde die is verhoogd ten opzichte van het onbehandelde plantaardige materiaal. Geen van de geciteerde documenten openbaart specifiek de Aufrère waardes (en/of de verhoging daarvan) en derhalve zijn conclusies 9 t/m 13 (letterlijk) nieuw.
Deze conclusies worden echter niet inventief bevonden.
Nergens uit de aanvraag wordt aannemelijk gemaakt dat deze (verhoogde) Aufrere waardes bijzonder zijn, bijvoorbeeld middels vergelijkende proeven ten opzichte van de huidige stand van de techniek waarin plantaardige materialen worden blootgesteld aan verwarming, al dan niet door middel van straling in het radio frequentiegebied. Derhalve betreffen de maatregelen van

conclusies 9 t/m 13 willekeurige maatregelen en worden conclusies 9 t/m 13 vooralsnog niet inventief geacht.

D3 en D4 betreffen secundaire stand van de techniek. Uit D3 is een werkwijze bekend waarbij een plantaardig materiaal wordt blootgesteld aan verwarming door middel van straling in het radio frequentiegebied. Het functionele kenmerk van het verhogen van de voedingswaarde van het plantaardige materiaal is echter niet bekend uit D3. D4 openbaart een werkwijze voor het verhogen van de voedingswaarde van een plantaardig materiaal door het blootstellen van een plantaardig materiaal aan verwarming in een oven. In D4 wordt geen gebruik gemaakt van straling in het radio frequentiegebied.

Onderdeel VIII Overige opmerkingen

De volgende opmerkingen met betrekking tot de duidelijkheid van de conclusies, beschrijving, en figuren, of met betrekking tot de vraag of de conclusies nawerkbaar zijn, worden gemaakt:

De woorden "bij voorkeur" in conclusies 1, 4, 5, 7, 10, 14 en 15 zijn niet beperkend en de zinsneden achter deze woorden kunnen daarom worden weggedacht.