

IMPROVMENTS IN PROCESSING OF FOOD MATERIALS**Technical Field**

[0001] The present invention relates to methods and apparatus for preparing comminuted food materials for dehydration. In a particular form, the invention relates to methods and apparatus for preparing comminuted food waste materials for dehydration for subsequent use as an ingredient for an animal food.

Background Art

[0002] Almost a third of food produced for human consumption is reportedly wasted, at enormous economic and environmental cost. Disposing of food waste on a commercial scale has become increasingly problematic, as it is generally no longer acceptable to send all food waste to landfill. Many ingenious solutions have been proposed to the food waste problem, however few of these solutions have realised commercial success.

[0003] In one of such solutions, one of the present inventors made an invention relating to a unique method for recycling food waste. This invention is described in international (PCT) application no. PCT/AU2017/051130, the content of which is hereby incorporated in its entirety into this specification. In realizing this invention on a commercial scale, however, additional problems became apparent, some of which were solved by the invention the subject of international (PCT) application no. PCT/AU2023/050227, the content of which is also hereby incorporated in its entirety into this specification.

[0004] In the process disclosed in PCT/AU2023/050227, categorised streams of food waste (with different average nutritional profiles) are dehydrated into granular powder form, typically having about a 10% moisture content. Batches of each of these categories of treated food wastes are then homogenised and their nutritional content and amino acid profiles determined. Once the nutritional profile of each batch is known, it is then treated as an ingredient for mixing with other batches in order to produce animal feeds having precise nutritional compositions. Such products have a comparable nutritional profile, and therefore are as valuable as, animal feeds produced from fresh ingredients, despite having been produced from food waste ingredients.

[0005] In further practice of this invention, however, problems specific to processing certain types of food waste were encountered, such problems including handling difficulties, loss of nutrient content and a relatively shorter shelf life of some of the categories of treated food wastes.

Summary of Invention

[0006] In a first aspect, the present invention provides an apparatus for preparing a comminuted food material for dehydration. The apparatus comprises a mixing chamber comprising first and second inlets and an outlet that communicates with an inlet of a dehydrator, the first inlet being configured to receive a comminuted food material having a determined moisture content, and the second inlet being configured to receive a second food material having a moisture content that is different to the moisture content of the comminuted food material. The apparatus also comprises a mister configured to apply a mist of water into the mixing chamber, and a mixer configured to mix a quantity of the second food material with the comminuted food material in the mixing chamber, whereby the resultant mixture at the outlet has a predetermined moisture content and a predetermined starch content.

[0007] As described above, during practice of the invention disclosed in PCT/AU2023/050227, the inventors discovered that some categories of food waste are more susceptible to their nutritional content being detrimentally affected during processing (particularly during heating) and/or, following processing, result in a product that is less free-flowing (tending to form clumps) and which has shorter storage stability than those produced from other categories of food waste. The inventors have surprisingly discovered that these problems can be avoided by presenting a comminuted feed material to the dehydration step which has a moisture and starch content which falls within a particular range and that results in gelatinisation occurring on the particle's surface during dehydration. The inventors initially considered it to be counter intuitive to add moisture to a product shortly before it was dehydrated, but now believe that this surface film of water, in combination with the mixed material's starch content, promotes gelatinisation and hence the advantageous effects described herein.

[0008] Without wishing to be bound by theory, the inventors believe that the starch/moisture content of the mixture of comminuted food material presented to the dehydrator results in a gelatinised surface coating being relatively quickly formed on the particles in the flash drying step. This coating is believed to protect the nutrients during the particles' subsequent heating, effectively insulating the nutrients in the material from the high temperatures, while allowing chemically unbound moisture to exit. Gelatinisation is also thought to cause swelling, which may result in a more aerated product, potentially further aiding its digestibility.

[0009] The present invention is thus thought to use gelatinisation as a means to protect the nutrients during heating, and which may also help to increase the digestibility of the end product. The present invention has also been found to significantly reduce the rate of oxidation of fatty

food wastes processed in accordance with the invention, both extending their shelf life and improving their handling characteristics.

[0010] The present invention also advantageously overcome problems associated with dehydrating comminuted food wastes that have variable water contents or which are either too wet or (less commonly) too dry. Once fed into the dehydrators used in the inventors' trials, the food waste is quickly broken up into even smaller particles. Particles that are relatively dry may be damaged due to excessive heat, whilst particles that are relatively wet may not sufficiently dehydrate. In use of the present invention, however, the blending of a second (usually drier) material into the comminuted food waste ensures that an appropriate mixing takes place and that the material presenting to the dehydrator has both a relatively consistent moisture content, as well as a target moisture content (e.g. 50% moisture). The dehydrator can thus be operated to dehydrate the entity of the resultant mixture (having a relatively homogeneous moisture content), with a reduced risk of any damage to the material occurring. In effect, the integrity of the amino acids and nutrient content of the food material is better retained during performance of the present invention. As would be appreciated, excess heat can be detrimental to the nutritional content of many categories of food.

[0011] In a second aspect, the present invention provides an apparatus for processing a comminuted food material. The apparatus comprises an apparatus according to the first aspect of the present invention, a dehydrator for flash drying the resultant mixture (i.e. of the comminuted food material and the second food material), and a heating chamber configured to maintain the flash dried comminuted food material at a temperature and for a time effective to inactivate all pathogens.

[0012] In a third aspect, the present invention provides a method for preparing a comminuted food material (e.g. a food waste material) for dehydration. The method comprises mixing a comminuted food material having a first moisture content with a second food material having a different moisture content, whereby the resultant mixture has a second moisture content and a predetermined starch content. Optionally, if the second moisture content is lower than a predetermined moisture content for dehydration, a mist of water is applied to the resultant mixture such that the resultant mixture has the predetermined moisture content.

[0013] In a fourth aspect, the present invention provides a method for producing a biosecure ingredient for a food product (e.g. an animal feed). The method comprises preparing a comminuted food material (e.g. a food waste material) for dehydration, flash drying the resultant mixture under conditions whereby an outer surface of the flash dried food material is gelatinized

and maintaining the flash dried food material at a temperature and for a time effective to inactivate all pathogens. The method for preparing the comminuted food material for dehydration comprises mixing a comminuted food material having a first moisture content with a second food material having a different moisture content, whereby the resultant mixture has a second moisture content and a predetermined starch content. Optionally, if the second moisture content is lower than a predetermined moisture content for dehydration, a mist of water is applied to the resultant mixture such that the resultant mixture has the predetermined moisture content.

[0014] The second and fourth aspects of the present invention provides for a biosecurity treatment. For example, the method may include a biosecurity treatment comprising maintaining the flash dried comminuted food material produced in the dehydrator at a temperature of at least 100°C for a period of at least 30 minutes. Heating to this temperature and for this time will ensure that any pathogens (e.g. microorganisms and viruses) that may be present in the dehydrated granular powder have been killed. Post-processing, the dehydrated granular powder is entirely biosecure and thus will not be a source of bacterial, viral, fungal or any other pathogenic contamination, any of which are undesirable in an industrial environment or might cause downstream spoilage. The bio secure granular powders of dehydrated food wastes produced by this method are pathogen-free and can thus be stored for longer periods of time without spoilage issues.

[0015] Additional features and advantages of the various aspects of the present invention will be described below in the context of specific embodiments. It is to be appreciated, however, that such additional features may have a more general applicability in the present invention than that described in the context of these specific embodiments.

Brief Description of Drawings

[0016] Embodiments of the present invention will be described in further detail below with reference to the following drawing, in which:

[0017] Figure 1 shows a schematic overview of an apparatus for preparing a comminuted food material for dehydration in accordance with an embodiment of the present invention.

Description of Embodiments

[0018] As noted above, the present invention relates generally to apparatus and methods for preparing comminuted food materials for dehydration and to apparatus and methods for producing biosecure ingredients for food products (particularly animal feeds). The food materials described below are generally provided in the form of food waste materials, which have been categorised according to the category of food waste producer from which the food waste is sourced, as is described in further detail in PCT/AU2017/051130 and PCT/AU2023/050227. It is to be appreciated, however, that the present invention has a more general applicability to many other food products.

[0019] As used herein, the term “food waste”, and the like, is intended to encompass all kinds of food wastes, including (but not limited to) coffee grounds, vegetable matter, dairy products, bakery waste, meat off-cuts and bones, and seafood shells (e.g. oysters, mussels, lobsters, etc.).

[0020] As used herein, the term “food waste producers”, “producers of food waste” and the like, is intended to encompass any establishment that produces a viable quantity of food waste on a regular basis. Food waste producers include, but are not limited to, restaurants, cafes, pubs/clubs, retirement homes, hospitals, supermarkets, grocers, greengrocers, delicatessens, butchers and bakeries.

[0021] As used herein, the terms “categories of food waste”, “categorised producers of food waste” and the like, relate to distinct streams of food wastes and sources of these wastes which, because of their common origin, will have a relatively consistent composition (and hence nutritional profiles and physical properties) between successive batches. Categories of food wastes include those described immediately above, which are produced by the respective food waste producers described in the preceding paragraph. By way of example, one category of food waste may be bread products (e.g. obtained as waste from a bakery) and another category of food waste, to be collected, maintained and processed separately from the bakery waste, may be meat offcuts (e.g. obtained as waste from a butcher).

[0022] As described in PCT/AU2017/051130, it was discovered that certain categories of food wastes can be processed to produce ingredients for animal feeds that have a relatively consistent nutritional profile. For example, food wastes from bakeries, cafés and butchers, can be processed separately to produce ingredients having different nutritional profiles for a resultant animal feed. Such ingredients provide for a myriad of blending opportunities for producing animal feeds having nutritional contents that enable them to command a premium price. This

invention has been successfully performed and has resulted in the production of animal feeds such as chicken feed, prawn feed and fish feed.

[0023] It was subsequently discovered, however, that there are slight variations between batches of the categorised food wastes, even if taken from exactly the same producer of the food waste. In some applications, these variations may be tolerable. However, premium animal food products (e.g. chicken feeds) have very exacting requirements, and these variations are not compatible with such food products. The homogenisation, analysis and blending steps in the process of the invention the subject of PCT/AU2023/050227 were found to provide an elegant solution to this problem. In the process disclosed in PCT/AU2023/050227, categorised streams of food waste (with slightly different average nutritional profiles) are dehydrated into granular powder form (typically having about a 10% moisture content). Batches of each of these categories of treated food wastes are then homogenised and their nutritional content and amino acid profiles determined. Once the nutritional profile of each batch is known, it is then available as an ingredient for mixing with other such ingredients (i.e. from a different category of food waste, and hence one having a different nutritional profile) in order to produce bespoke animal feed.

[0024] The process disclosed in PCT/AU2023/050227 enables the production of animal feeds having precisely defined nutritional profiles using primarily only food waste. Further, given the variety of food waste sources which can be utilised, the ingredients produced have a correspondingly diversity of nutritional parameters. Such a diverse feedstock of immediately available ingredients provides a great number of blending opportunities for producing animal feed having practically any given composition. Indeed, animal feeds meeting exacting criteria (e.g. chicken feed) were produced without the requirement for any macro-ingredients other than those obtained from the food wastes. The benefits in terms of cost and guaranteed supply of ingredients are immediately apparent.

[0025] In commercial-scale operation of these processes, however, certain categories of food wastes (particularly fatty food wastes) were found to be prone to clumping after dehydration/biosecurity treatment, making them more difficult to further process than other categories of food wastes. Furthermore, processed batches of these categories of food wastes were found to be less storage stable than other categories of food wastes, and more prone to degradation of their nutritional content. The discovery underling the present invention helps to solve these problems by ensuring that the material presents to the dehydrator in a form whereby an outer surface of the dehydrated/flash dried food material is gelatinised. Such gelatinisation

results in the product having the favourable physical and chemical properties of the other processed categories of food wastes.

[0026] The present invention provides an apparatus and a method for preparing a comminuted food material for dehydration. The apparatus includes a mixing chamber comprising first and second inlets and an outlet that communicates with an inlet of a dehydrator. The first inlet is configured to receive a comminuted food material having a determined moisture content, and the second inlet is configured to receive a second food material which has a moisture content that is different to the moisture content of the comminuted food material. The apparatus also includes a mister configured to apply a mist of water to the resultant mixture, and a mixer configured to mix a quantity of the second food material with the comminuted food material in the mixing chamber, whereby the resultant mixture (i.e. that which presents to the outlet/dehydrator) has a predetermined moisture content and a predetermined starch content.

[0027] The method for preparing a comminuted food material for dehydration/flash drying comprises mixing the comminuted food material having a first moisture content with a second food material having a different moisture content, whereby the resultant mixture has a second moisture content and a predetermined starch content. Optionally, if the second moisture content is lower than a predetermined moisture content for dehydration, a mist of water is applied to the resultant mixture such that the resultant mixture has the predetermined moisture content.

[0028] The comminuted food material may be any food material suitable for dehydrating which has been comminuted such that it has a particle size consistent with dehydration in apparatus such as flash dryers (e.g. between about 2-3mm). In PCT/AU2017/051130 and PCT/AU2023/050227, the food waste materials which underwent processing were categorised based on their source, as described above. It is to be appreciated, however, that any suitable food material in need of dehydration could be utilised in the present invention, and particularly where its nutritional content makes it susceptible to heat damage.

[0029] The mixture of food materials that presents to the dehydrator has a predetermined moisture content and a predetermined starch content. As described above, the inventors have discovered that dehydration of such material can result in a product having an improved nutrient content (i.e. compared to what it would have been if gelatinisation was not caused to occur) and having an enhanced storage stability and handleability (noting that pneumatic conveying is extensively used in embodiments of the processes described in PCT/AU2023/050227). The inventors have found that this applies particularly to fatty food wastes (e.g. from butchers or

some restaurants), although note that these benefits may also be seen for many other types of food wastes.

[0030] Either (or both) of the comminuted food material or the second food material may contain the starch required to cause the gelatinisation described herein. Typically, however, the second food material is a starch containing food material. Starch containing food materials which the inventors have trialled include spent brewers grain and low grade wheat. Typically, a relatively drier second food material is added into a relatively wetter comminuted food waste, but this need not always be the case.

[0031] The proportion of the second food material mixed into the comminuted food material may depend on factors such as the composition of the second food material, the desired moisture and starch contents of the resultant mixture (primarily the moisture content). In some embodiments, for example, the proportion of the second food material mixed into the comminuted food waste may be up to about 10, 20, 30, 40 or 50% by weight.

[0032] Mixing of the second food material into the comminuted food material shortly before the resultant mixture is fed into the dehydrator ensures that the material presenting to the dehydrator has a known and substantially homogeneous moisture content, and one which is appropriate for the dehydrator. The dehydrator can thus be operated to dehydrate the entirety of the (substantially homogeneous, at least from a moisture perspective) mixture, with particular efficiency and with a reduced risk of causing heat damage to any portion of the material. Advantageously, as the moisture content of the resultant mixture is known, the dehydrator can be operated using a standard operational procedure, which would not be the case if material having highly variable moisture content were to present.

[0033] The quantity, relative moisture content and mixing technique will all affect the properties of the resultant mixture headed into the dehydrator. The quantity of the second food material added to the comminuted food material may, for example, be adjustable to achieve a specific moisture content. Similarly, a rate at which the material is added to the comminuted food may be adjustable to achieve a specific moisture content. Alternatively, or in addition, a smaller amount of a relatively drier second food material may be used.

[0034] The invention also includes mixing the second food material and the comminuted food material in a manner whereby the resultant mixture for feeding into the dehydrator has a defined and substantially homogeneous moisture content. Such mixing may be achieved using any conventional technique, and preferably one that results in compressing of the materials together, thus causing a rapid moisture exchange between the relatively wetter/drier materials. In the

embodiments described herein, a double screw auger is used to provide a continuous mixing of the materials as they advance towards the dehydrator, but other continuous mixtures could be used to similar effect.

[0035] The defined moisture content (i.e. of the mixture fed into the dehydrator) may be between about 5% and 80%, between about 20% and 70%, between about 30% and 60%, and more preferably at about 50% (w/w).

[0036] The apparatus of the present invention also includes misters that can apply a mist of water onto the resultant mixture at some stage before entering the dehydrator. Any suitable misters may be used. The mist may be applied at any convenient stage, such as when the second food material and the comminuted food material are introduced into the mixing chamber, or shortly before entering the dehydrator. In order for gelatinisation to occur upon heating, both starch and moisture need to be present. As noted above, the inventors surprisingly and unexpectedly discovered that wetting a food material immediately before it is flash dried, whilst ensuring an appropriate starch availability, provided the advantageous effects described herein.

[0037] Dehydration of the mixture may be performed using any commercially available dehydrator. Many of the inventors' trials have been carried out using dehydrators sourced from AKT International and as described, for example in international (PCT) patent application no. PCT/AU89/00475, the content of which is hereby incorporated in its entirety into this specification.

[0038] Typically, dehydrating the mixture comprises agitating the mixture in a flow of hot air. Typically, the hot air has a temperature of about 350°C and dehydration takes less than 10 seconds. In alternative embodiments, hotter temperatures (e.g. 375°C, 400°C or 425°C) may be used, typically with shorter residence times (e.g. 5-10 seconds), provided of course that the higher temperature does not adversely affect the material. Conversely, lower temperatures (e.g. 275°C, 300°C or 325°C) may be used, typically with shorter residence times (e.g. 10-15 or 10-20 seconds).

[0039] The material presenting to the dehydrator advantageously has a substantially consistent moisture content and the dehydrator thus able to be operated using standard operating procedures. In some embodiments, however, the method may further comprise measuring a moisture content of the dehydrated comminuted food waste (i.e. that exiting the dehydrator). Such a measurement can advantageously provide feedback for the operational parameters of the dehydrator (e.g. the temperature of the dehydrator, the feed rate of the "wet" material into the dehydrator and the residence time of the material in the dehydrator). For example, if a moisture

content of the dehydrated granular powder exiting the dehydrator is deemed too high, then the operational parameters of the dehydrator can be adjusted (preferably automatically, by a computer-operated system) to cause a greater amount of dehydration. Similarly, if a moisture content of the dehydrated granular powder exiting the dehydrator is deemed too low, then the operational parameters of the dehydrator can be adjusted to cause a lesser amount of dehydration.

[0040] The moisture content of the dehydrated particulate material exiting the dehydrator may be between about 1% and 12%. Materials having a moisture content above 12% are highly susceptible to microbial growth during storage. Preferably therefore, the dehydrated particulate material exiting the dehydrator has a moisture content below about 10% or about 8%. Materials having a moisture content below 8% are generally not susceptible to microbial growth during storage.

[0041] As described herein, the apparatus may include one or more moisture detectors configured to detect a moisture content of the food material at various stages. Moisture detectors such as the MCT460 Online Smart NIR Sensor Series produced by KPM Analytics are expected to be suitable for this purpose. In some embodiments, a detector configured to detect moisture may also be configured to detect other properties of the material under analysis. Such properties may include its starch, fat and/or protein content. Whilst more expensive, moisture detectors providing such an enhanced functionality may provide advantages in performance of the invention.

[0042] The apparatus also includes a mixer for mixing the second food material and the comminuted food waste in a manner whereby the resultant mixture presents to the dehydrator having its defined and substantially homogeneous moisture content. Again, any apparatus capable of providing this functionality, given the context of the invention, may be used for such mixing. The apparatus may provide for a continuous or batch delivery of the “wet” materials to the dehydrator. In the embodiments described below for example, a screw auger is used for mixing the materials before they are fed into the dehydrator. A person skilled in the art would recognise other suitable apparatus for this purpose.

[0043] Some aspects of the invention provide for a biosecurity treatment in addition to the dehydration described above. Whilst a biosecurity step could be carried out at a different stage of the overall process, operational efficiencies may be achieved when still-warm material is presented to the biosecurity treatment.

[0044] In this regard, the present invention also provides an apparatus and a method for dehydrating a comminuted food material (e.g. a food waste material) and producing a biosecure food ingredient. The apparatus of this aspect of the present invention includes an apparatus for preparing a comminuted food material as described herein, a dehydrator for flash drying the mixture of comminuted food material, and a heating chamber configured to receive the flash dried comminuted food material and to maintain the dried food material at a temperature and for a time effective to inactivate all pathogens.

[0045] The method includes preparing a comminuted food material for dehydration/flash drying, flash drying the resultant mixture under conditions whereby a surface of the flash dried food material is gelatinized and maintaining the flash dried food material at a temperature and for a time effective to inactivate all pathogens. The method for preparing the comminuted food material for dehydration may be as described above.

[0046] The biosecurity treatment may, for example, comprise maintaining the dehydrated product produced in the dehydrator at a temperature of at least 100°C for a period of at least 30 minutes. Heating to this temperature and for this time will ensure that any pathogens (e.g. microorganisms and viruses) that may be present in the dehydrated granular powder have been killed. Post-processing, the dehydrated granular powder is entirely biosecure and thus will not be a source of bacterial, viral, fungal or any other pathogenic contamination, any of which are undesirable in an industrial environment or might cause downstream spoilage. The biosecure granular powders of macerated and dehydrated food wastes produced by this method are shelf-stable and pathogen-free and can thus be stored for longer periods of time without spoilage issues.

[0047] Biosecurity of food products is of paramount importance when these are sold to a consumer, but such is less regulated when it comes to food waste. If food waste is to be used in the production of animal feed, however, then it is vital that it is biosecure, as many threats to animal welfare could present in unsafe feed. By way of example, such threats may include African swine fever, Aujeszky's disease and Brucella suis in pigs; arboviruses, avian adenovirus and avian Influenza in poultry; as well as foot and mouth disease in livestock.

[0048] In the biosecurity heat treatment, the material must be heated at a temperature and for a time effective to kill all pathogens (including all microorganisms such as bacteria and fungi) and all viruses. Biosecurity heating protocols may be governed by regulation, based on scientific evidence or empirical determination, but all result to total pathogen inactivation. The inventors have found that heating dehydrated granular powders of food waste for at least 30 minutes (e.g.

30-35 minutes) at a temperature of at least 100°C (this being the temperature experienced by the powder, not necessarily the chamber temperature) is effective to kill all potential microorganisms. Higher temperatures may be used, but heating to such may adversely affect the nutrient content of the resultant biosecure product.

[0049] Once the biosecurity heat treatment has been conducted, the biosecure product is cooled. Relevant measurements may be taken at this time, such as the weight of the biosecure product. Cooling may occur naturally, due to exposure to ambient conditions, or may be controlled using a coolant (e.g. a cooled sleeve of an auger). Cooling may take an appropriate time and would typically occur over a period of between about 3 to about 15 minutes.

[0050] The biosecurity treatment may be carried out in any suitable apparatus, such as a screw auger, which the inventors have found prevents clumping of granular particles of food wastes, which can occur as some categories of food waste cool down after being heated (this has been found to be a particular problem when processing food waste streams that have a relatively high fat content).

[0051] Post-treatment, the still-warm dehydrated product may be agitated as it cools, in a manner that prevents clumping of the product from occurring. If the dehydrated product is cooled in a screw auger, it is constantly turned over by the screw whilst it moves through the (optionally cooled) sleeve. As would be appreciated, however, many other apparatuses could provide a similar functionality.

[0052] The cooled dehydrated granular powder typically has a particle size of between about 1-3mm. Such powders are easily transported using pneumatic conveyors.

[0053] A specific embodiment of an apparatus and method for preparing a comminuted food waste material for dehydration, and which incorporates various embodiments of the aspects of the present invention, will now be described with reference to Figure 1.

[0054] Figure 1 is a schematic diagram of an apparatus for preparing a comminuted food waste material for dehydration, shown in the form of apparatus 10. Apparatus 10 is configured to receive a comminuted food waste material that has been prepared, for example, using the method disclosed in PCT/AU2017/051130 or PCT/AU2023/050227. The mixture of food materials, having a known moisture and starch content, exit apparatus 10 into a dehydrator (not shown) where they are dehydrated. Optionally, the dehydrated material is made biosecure via a subsequent heating step. The dehydration and biosecurity heating steps may, for example, be as described in PCT/AU2023/050227.

[0055] Apparatus 10 includes a mixing chamber 12, which is in fluid communication with first inlet 14 and second inlet 16. An auger 18 moves comminuted food waste through a conduit that ends at first inlet 14, such that actuation of the auger 18 advances the comminuted food waste through the conduit and into the mixing chamber 12. A similar auger (not shown) may be used to advance food material through second inlet 16.

[0056] Mixing chamber 12 includes a mister 20, which sprays a fine mist onto the surfaces of the comminuted food waste passing through the first inlet 14 and food material passing through the second inlet 16. A volume of mist can be determined empirically or based on moisture level measurements taken during operation (as described below).

[0057] The second food material, in this embodiment, is a relatively dry food, having a moisture content which is lower than that of the comminuted food waste. Mixing of the streams of food waste from inlets 14 and 16 thus reduces the moisture content of the relatively wetter comminuted food waste. A rate at which the second food waste is advanced through inlet 16 can be increased or decreased in order to relatively decrease or increase the proportion of the second food waste in, and hence the moisture content of, the resultant mixture.

[0058] The second food waste may be used to control both the moisture content and the starch content of the resultant mixture. For example, the second food waste may be provided in the form of a relatively dry food material that has a high starch content (e.g. spent brewers grain). Mixing such into a comminuted food waste would reduce the moisture content and increase the starch content of the comminuted food waste, with the quantum of the second food waste added being determined such that the resultant mixture (i.e. which presents to the dehydrator) has the necessary moisture and starch content.

[0059] In alternative embodiments, for example, where a comminuted food waste high in starch is to be processed, a relatively smaller amount of the second food waste may be required. If the comminuted food waste is too dry, additional moisture may be added using the mister 20.

[0060] Mixing auger 22 is a double auger, of the kind that provides for a continuous mixing whilst advancing material through the conduit. Auger 22 compresses the two materials together and agitates them such that a through mixing takes place, whilst also progressing the increasingly well mixed food materials towards the dehydrator (not shown).

[0061] In-line detectors 24 and 26 may be used to provide an accurate measure of the moisture level (and/or starch content, etc.) of the resultant mixture headed for the dehydrator and the comminuted food waste passing through first inlet 14, respectively.

Example

[0062] Preliminary trials have been conducted to evaluate the benefits and effectiveness of gelatinisation in food waste processing in accordance with embodiments of the present invention. The aim of these trials was to assess the impact of gelatinisation on nutritional content and product quality by incorporating different ratios of starch products and moisture content into categorised food wastes.

[0063] As described above, the inventors discovered that food waste with high fat and oil content tends to clump during dehydration, leading to burning. Furthermore, food waste materials with lower fat content, such as fruits and vegetables, were found to be more susceptible to degradation because of their higher moisture levels and corresponding requirement for increased heat and/or prolonged time to achieve adequate dehydration.

[0064] The inventors surprisingly discovered that adding starch products at appropriate ratios to such food waste streams facilitates gelatinisation, which they discovered resulted in dehydrated products having reduced degradation, consistent moisture content, as well as decreased clumping and burning.

[0065] To determine an appropriate balance for effective gelatinisation, tests were conducted using varying ratios of starch product added to food waste material, based on weight, volume, temperature, and pre-dehydration moisture content.

[0066] Fruit and vegetable materials were mixed with starch products to produce different total combined moisture contents (10%, 20%, 30%, 40%, 50%, 60%, 70%, and 80%). The same method was applied for materials with higher fat/oil content. An auger was implemented during the post dehydration step while cooling to minimise clumping further.

[0067] To ensure effective gelatinisation, additional moisture sprayers were implemented to maintain consistent moisture content pre-dehydration. Temperature range during dehydration did not significantly affect gelatinisation performance. Thorough mixing of starch material with waste was crucial for uniform moisture distribution throughout the batch.

[0068] The addition of starch products resulted in improved reduction of nutritional degradation across all tested products during flash drying. The higher and lower extremities of the pre-dehydration moisture contents showed a relatively increased degradation compared to products that were presented to the dehydrator having a moisture content of around 50%. Visual observations also indicated inadequate gelatinisation at both higher and lower extremes of moisture contents.

[0069] With proper addition of starch products and a pre-dehydration moisture content around 50%, significant reduction in clumping occurred. Further, no burning was observed when using starch additives alongside a pre-dehydration moisture content of 50%. The overall nutritional content experienced the least degradation at this level, attributed to reduced processing heat and time, as well as the protective effect of gelatinisation on molecular structure.

[0070] The trials conducted demonstrated that gelatinisation in food waste processing offers several benefits:

- Reduction in nutritional degradation
- Decreased clumping and burning
- More consistent product quality

[0071] It will be appreciated that the present invention provides a number of new and useful advantages. For example, specific embodiments of the present invention may provide one or more of the following advantages:

- ingredients for animal feed are produced having an improved nutritional content (compared to earlier processes), despite having undergone a heating and biosecurity treatment;
- ingredients for animal feed are produced having an improved handleability and storage stability;
- less food waste is sent to landfill; and
- the environmental benefits of beneficially reusing food waste as ingredients for animal feed instead of having to source commercial ingredients (which could otherwise be put to more beneficial use – e.g. as human food).

[0072] It will be understood to persons skilled in the art of the invention that many modifications may be made without departing from the spirit and scope of the invention. All such modifications are intended to fall within the scope of the following claims.

[0073] In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word “comprise” or variations such as “comprises” or “comprising” is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.

[0074] It is to be understood that any prior art publication referred to herein does not constitute an admission that the publication forms part of the common general knowledge in the art.

CLAIMS:

1. An apparatus for preparing a comminuted food material for dehydration, the apparatus comprising:
 - a mixing chamber comprising first and second inlets and an outlet that communicates with an inlet of a dehydrator, wherein:
 - the first inlet is configured to receive a comminuted food material having a determined moisture content, and
 - the second inlet is configured to receive a second food material having a moisture content that is different to the moisture content of the comminuted food material;
 - a mister configured to apply a mist of water into the mixing chamber; and
 - a mixer configured to mix a quantity of the second food material with the comminuted food material in the mixing chamber, whereby the resultant mixture at the outlet has a predetermined moisture content and a predetermined starch content.
2. The apparatus of claim 1, wherein the mister is configured to apply a continuously variable volume of mist into the mixing chamber, wherein the volume is determined based on a difference between the moisture content of the comminuted food material and the predetermined moisture content of the resultant mixture at the outlet.
3. The apparatus of claim 1 or claim 2, comprising an inlet moisture detector proximal to the first inlet, the inlet moisture detector being configured to detect the moisture content of the comminuted food material.
4. The apparatus of any one of claims 1 to 3, comprising an outlet moisture detector configured to detect a moisture content of the resultant mixture.
5. The apparatus of claim 3 or claim 4, wherein the inlet and/or outlet moisture detector is an in-line near infrared moisture meter.
6. The apparatus of any one of claims 1 to 5, comprising a starch detector configured to detect a starch content of the comminuted food material.
7. The apparatus of any one of claims 1 to 5, wherein the mixer comprises a screw auger for mixing the second food material with the comminuted food material.

8. An apparatus for processing a comminuted food material, the apparatus comprising:
 - an apparatus according to any one of claims 1 to 7;
 - a dehydrator for flash drying the resultant mixture; and
 - a heating chamber configured to maintain the flash dried food material at a temperature and for a time effective to inactivate all pathogens.
9. The apparatus of claim 8, further comprising a third moisture meter for measuring a moisture content of the flash dried food material.
10. The apparatus of claim 8 or claim 9, wherein the heating chamber comprises a screw auger that is configured to agitate the flash dried food material, whereby clumping is substantially prevented.
11. The apparatus of any one of claims 8 to 10, further comprising an agitator which agitates the pathogen-free flash dried food material as it cools to ambient temperature.
12. The apparatus of claim 11, wherein the agitator comprises a second screw auger.
13. The apparatus of claim 12, wherein the second screw auger comprises a water-cooled sleeve.
14. A method for preparing a comminuted food material for dehydration, the method comprising:
 - mixing a comminuted food material having a first moisture content with a second food material having a different moisture content, whereby the resultant mixture has a second moisture content and a predetermined starch content; and
 - optionally, if the second moisture content is lower than a predetermined moisture content for dehydration, applying a mist of water to the resultant mixture such that the resultant mixture has the predetermined moisture content.
15. The method of claim 14, wherein the second food material has a relatively lower moisture content than the comminuted food material.
16. The method of claim 14 or claim 15, wherein the second food material is a starch-containing food material.
17. The method of claim 16, wherein an amount of the second food material mixed into the comminuted food material is adjustable such that the resultant mixture has the predetermined starch content.
18. The method of any one of claims 14 to 17, wherein the predetermined moisture content is about 50%.

19. A method for producing a biosecure ingredient for a food product, the method comprising:
preparing a comminuted food material for dehydration, comprising:
 mixing a comminuted food material having a first moisture content with a second food material having a different moisture content, whereby the resultant mixture has a second moisture content and a predetermined starch content; and
 optionally, if the second moisture content is lower than a predetermined moisture content for dehydration, applying a mist of water to the resultant mixture such that the resultant mixture has the predetermined moisture content;
flash drying the resultant mixture under conditions whereby an outer surface of the flash dried food material is gelatinized;
maintaining the flash dried food material at a temperature and for a time effective to inactivate all pathogens.
20. The method of claim 19, wherein flash drying comprises agitating the resultant mixture in a flow of hot air.
21. The method of claim 20, wherein the hot air has a temperature of about 350°C and dehydration takes less than 10 seconds.
22. The method of any one of claims 19 to 21, wherein a moisture content of the flash dried food material is measured.
23. The method of claim 22, wherein operational parameters of the flash dryer are adjustable based on the measured moisture content of the flash dried food material.
24. The method of claim 23, wherein the operational parameters are selected from one or more of: a temperature of the flash dryer, a feed rate into the flash dryer and a residence time in the flash dryer.
25. The method of any one of claims 19 to 24, wherein the flash dried food material is maintained at a temperature at least 100°C for at least 30 minutes.
26. The method of any one of claims 19 to 25, wherein the pathogen-free flash dried food material is agitated as it cools to ambient temperature.
27. The method of any one of claims 14 to 26, wherein the comminuted food material is a comminuted food waste material.
28. The method of any one of claims 19 to 26, wherein preparing a comminuted food material for dehydration comprises the method of any one of claims 14 to 18.