A METHOD OF IMPROVING THE SHELF LIFE OF A FOOD PRODUCT AND A FOOD PRODUCT WITH AN IMPROVED SHELF LIFE

TECHNICAL FIELD

The present disclosure relates broadly to a method of improving the shelf life of a food product and a food product with an improved shelf life.

BACKGROUND

In general, fresh food products possess superior organoleptic characteristics over dried food products. For example, fresh noodles such as rice-based noodles and wheat-based noodles generally possess superior organoleptic characteristics in terms of freshness, texture, color, taste and mouthfeel, as compared to dried noodles. However, fresh food products such as fresh noodles typically have a shelf life that is limited to a few days at ambient temperature. This may be due to their high moisture content increasing spoilage and promoting proliferation of mold growth, hence resulting in the food products becoming unsuitable for use or consumption.

There are different methods of treatment practiced in the current art to extend the shelf life of fresh food products such as fresh noodles. However, there are many disadvantages associated with such methods of treatment, including higher costs of production which translate into higher selling prices, impairment of the texture, color and/or taste of the food product, and adverse effects on human health.

In one example, fresh noodles may be kept in refrigerators or chillers at the supermarket. However, fresh noodles that are kept in refrigerators or chillers

tend to harden due to increased rate of retrogradation at chilled temperature and this affects the texture quality of fresh noodles.

In another example, fresh noodles may be pasteurized to extend their ambient shelf life to about 3 months. Pasteurized fresh noodles are commonly available in supermarkets, including pasteurized fresh pasta, pasteurized fresh Hokkien noodles, pasteurized Bee Tai Mak, etc. However, due to starch leeching from the fresh noodles after pasteurization and the natural process of retrogradation, the fresh noodles, e.g., rice-based noodles, tend to become brittle and hard, break easily and stick together even when substantial amount of oil is applied. In addition, the color of the fresh noodles, e.g., fresh white rice-based noodles also become less bright.

In a further example, chemical preservatives, e.g., Class 2 preservatives such as benzoates, sorbates or sulfites, may be used to delay microbial growth and extend shelf life of a food product with minimal effect on quality. However, there are adverse health effects when the use of chemical preservatives is above a certain limit. There are also food regulations in countries such as Singapore that do not allow the use of such chemical preservatives in fresh food products.

Thus, there is a need for a method of improving the shelf life of a food product and a food product with an improved shelf life, which seeks to address or at least ameliorate one of the above problems.

SUMMARY

In one aspect, there is provided a method of improving the shelf life of a food product, the method comprising, providing a food product comprising alginate; applying a treatment solution comprising a calcium source to the food product; and forming a coating of calcium alginate on an external surface of the food product.

In some embodiments of the method as disclosed herein, the food product further comprises from 0.1% (w/w) to 2% (w/w) of a food-grade phosphate.

In other embodiments of the method as disclosed herein, the food product further comprises from 5% (w/w) to 15% (w/w) of at least one modified starch.

In other embodiments of the method as disclosed herein, the treatment solution further comprises from 0.5% (w/w) to 1.5% (w/w) of an acid.

In other embodiments of the method as disclosed herein, the treatment solution further comprises from 1% (w/w) to 10% (w/w) of a soluble fiber.

In other embodiments of the method as disclosed herein, the treatment solution further comprises from 0.5% (w/w) to 2% (w/w) of calcium salt as the calcium source in the treatment solution.

In other embodiments of the method as disclosed herein, the step of providing the food product comprises steaming a slurry mixture to obtain one or more sheets of the food product.

In other embodiments, the method further comprises cutting the one or more sheets into elongate form, after applying the treatment solution and forming the coating of calcium alginate.

In other embodiments of the method as disclosed herein, the step of providing the food product comprises extruding fresh noodles from a dough via an extruder.

In other embodiments of the method as disclosed herein, applying the treatment solution comprises dipping a roller into the treatment solution and brushing the roller onto the food product; or immersing the food product in the treatment solution.

In other embodiments of the method as disclosed herein, applying the treatment solution comprises spraying the treatment solution from a spraying attachment onto the food product.

In other embodiments of the method as disclosed herein, applying the treatment solution comprising a calcium source to the food product comprises contacting the fresh noodles with the treatment solution for a duration of no more than 1 minute.

In other embodiments, the method further comprises packaging the food product without rinsing to remove residual treatment solution.

In other embodiments, the method further comprises pasteurizing or sterilizing the food product in a package, after applying the treatment solution and forming the coating of calcium alginate.

In other embodiments of the method as disclosed herein, the food product comprises rice-based noodles or wheat-based noodles.

In other embodiments of the method as disclosed herein, the food product has a shelf life of at least 6 months at ambient temperature of 25°C to 35°C.

In other embodiments of the method as disclosed herein, the food product treated with the treatment solution is substantially free of chemical preservatives.

In other embodiments of the method as disclosed herein, the food product treated with the treatment solution is substantially free of oil coating.

In another aspect, there is provided a food product with an improved shelf life, the food product comprising a coating of calcium alginate formed on an external surface thereof.

In some embodiments, the food product further comprises one or more of the following ingredients: 0.1% (w/w) to 2% (w/w) of pentasodium triphosphate (STPP); 5% (w/w) to 15% (w/w) of modified starch; an acid; and a soluble fiber.

DEFINITIONS

The term “food product” as used herein refers to a product suitable for human consumption and/or an intermediate preparation which is meant to deliver a finished product suitable for human consumption after being subject to additional processing step(s), e.g., a heat treatment step. The term “food product” as used herein refers to a food product that is in a fresh or moist/wet form, e.g., fresh noodles or wet noodles, as opposed to a food product that is in a dried or dehydrated form, e.g., dried noodles or instant noodles. In various embodiments, the food product referred herein has a moisture/water content of from about 20% to about 80%, from about 25% to about 75%, from about 30% to about 70%, from about 35% to about 65%, from about 40% to about 60%, from about 45% to about 55%, or from about 50% to about 55% by weight of the food product. In various embodiments, the moisture content criteria for differentiating between a fresh food product and a dried food product may be based on food regulation set out by the relevant agency in a particular country of interest. For example, in Singapore, food regulation set out by the relevant agency stipulates that a food product having a moisture content of at least about 20% by weight of the food product is classified as a fresh food product. In various embodiments, fresh rice noodles may have a moisture content of about 65% by weight or a moisture content falling in the range of from about 30% to about 80% by weight of the fresh rice noodles.

The term “rice-based” when used to describe a food product (i.e., “rice-based food product”) broadly covers any kinds of food products mainly composed of one or more rice flours, including rice particles grinded into liquid or slurry form and starches, with or without addition of eggs or yolks, and with or without

addition of any other additives. Examples of rice-based food products include, but are not limited to, Kway Teow, Ipoh Hor Fun, Hor Fun, Kway Chap, Bee Tai Mak, Laksa Noodles, Bee Hoon, rice noodle roll (also known as Chee Cheong Fun), Chwee Kueh and turnip cake (also known as radish cake or carrot cake). The rice-based food product may take a variety of forms, e.g., string, strip, wavy, helical, tubular, shell, spherical, ellipsoidal, and sheet forms.

The term “wheat-based” when used to describe a food product (i.e., “wheat-based food product”) broadly covers any kinds of food products mainly composed of wheat flour, with or without addition of eggs or yolks, and with or without addition of any other additives. Examples of wheat-based food products include, but are not limited to, Hokkien Noodles, Hokkien Flat Noodles, Mee Pok Noodles, Mee Kia Noodles, La Mian, Ban Mian, macaroni, wanton skin, dumpling skin, Popiah skin, pasta and Japanese style noodles such as ramen and udon. The wheat-based food product may take a variety of forms, e.g., string, strip, wavy, helical, tubular, shell, spherical, ellipsoidal, and sheet forms.

The term “shelf life” as used herein refers to a product’s commercially viable lifespan, after which the product is unfit or undesirable for sale and/or consumption based on microbiological safety limit and/or organoleptic property.

The term “organoleptic property” as used herein is to be interpreted broadly to include any property of a food product that appeals to a subject, e.g., human being, via one of the senses including taste, sight, smell, and touch. Examples of organoleptic properties include, but are not limited to, physical integrity, firmness, elasticity, color, texture, taste, mouthfeel, odor, moisture content, water loss property and the like.

The terms “chemical preservatives” and “Class II preservatives” as used herein refer to synthetically manufactured substances suitable for inhibiting or retarding deterioration when added to a food product. Examples of chemical preservatives and Class II preservatives include but are not limited to benzoates,

such as sodium benzoate, calcium benzoate, and potassium benzoate, sorbates, such as sodium sorbate, calcium sorbate, and potassium sorbate, nitrites and nitrates of sodium and potassium, glycerides, propionates and sulfites.

The term “layer” when used to describe a first material is to be interpreted broadly to refer to a first depth of the first material that is distinguishable from a second depth of a second material. The first material of the layer may be present as a continuous film, as discontinuous structures or as a mixture of both. The layer may also be of a substantially uniform depth throughout or varying depths. Accordingly, when the layer is formed by individual structures, the dimensions of each of individual structure may be different. The first material and the second material may be same or different and the first depth and second depth may be same or different.

The term “continuous” when used to describe a film or a layer is to be interpreted broadly to refer to a film or a layer that is substantially without gaps or holes or voids across the film or layer. In this regard, a continuous film or a continuous layer is also intended to include a film or a layer that may have trivial gaps or holes or voids that may not appreciably affect the desired properties of the film or the layer.

The term “particle” as used herein broadly refers to a discrete entity or a discrete body. The particle described herein can include an organic, an inorganic or a biological particle. The particle used described herein may also be a macro-particle that is formed by an aggregate of a plurality of sub-particles or a fragment of a small object. The particle of the present disclosure may be spherical, substantially spherical, or non-spherical, such as irregularly shaped particles or ellipsoidal shaped particles. The term “size” when used to refer to the particle broadly refers to the largest dimension of the particle. For example, when the particle is substantially spherical, the term “size” can refer to the diameter of the particle; or when the particle is substantially non-spherical, the term “size” can refer to the largest length of the particle.

The term “associated with”, used herein when referring to two elements refers to a broad relationship between the two elements. The relationship includes, but is not limited to a physical, a chemical or a biological relationship. For example, when element A is associated with element B, elements A and B may be directly or indirectly attached to each other or element A may contain element B or vice versa.

The term “and/or”, e.g., “X and/or Y” is understood to mean either “X and Y” or “X or Y” and should be taken to provide explicit support for both meanings or for either meaning.

Further, in the description herein, the word “substantially” whenever used is understood to include, but not restricted to, “entirely” or “completely” and the like. In addition, terms such as “comprising”, “comprise”, and the like whenever used, are intended to be non-restricting descriptive language in that they broadly include elements/components recited after such terms, in addition to other components not explicitly recited. For example, when “comprising” is used, reference to a “one” feature is also intended to be a reference to “at least one” of that feature. Terms such as “consisting”, “consist”, and the like, may in the appropriate context, be considered as a subset of terms such as “comprising”, “comprise”, and the like. Therefore, in embodiments disclosed herein using the terms such as “comprising”, “comprise”, and the like, it will be appreciated that these embodiments provide teaching for corresponding embodiments using terms such as “consisting”, “consist”, and the like. Further, terms such as “about”, “approximately” and the like whenever used, typically means a reasonable variation, for example a variation of +/- 5% of the disclosed value, or a variance of 4% of the disclosed value, or a variance of 3% of the disclosed value, a variance of 2% of the disclosed value or a variance of 1% of the disclosed value.

Furthermore, in the description herein, certain values may be disclosed in a range. The values showing the end points of a range are intended to illustrate

a preferred range. Whenever a range has been described, it is intended that the range covers and teaches all possible sub-ranges as well as individual numerical values within that range. That is, the end points of a range should not be interpreted as inflexible limitations. For example, a description of a range of 1% to 5% is intended to have specifically disclosed sub-ranges 1% to 2%, 1% to 3%, 1% to 4%, 2% to 3% etc., as well as individually, values within that range such as 1%, 2%, 3%, 4% and 5%. It is to be appreciated that the individual numerical values within the range also include integers, fractions and decimals. Furthermore, whenever a range has been described, it is also intended that the range covers and teaches values of up to 2 additional decimal places or significant figures (where appropriate) from the shown numerical end points. For example, a description of a range of 1% to 5% is intended to have specifically disclosed the ranges 1.00% to 5.00% and also 1.0% to 5.0% and all their intermediate values (such as 1.01%, 1.02% … 4.98%, 4.99%, 5.00% and 1.1%, 1.2% ... 4.8%, 4.9%, 5.0% etc.,) spanning the ranges. The intention of the above specific disclosure is applicable to any depth/breadth of a range.

Additionally, when describing some embodiments, the disclosure may have disclosed a method and/or process as a particular sequence of steps. However, unless otherwise required, it will be appreciated that the method or process should not be limited to the particular sequence of steps disclosed. Other sequences of steps may be possible. The particular order of the steps disclosed herein should not be construed as undue limitations. Unless otherwise required, a method and/or process disclosed herein should not be limited to the steps being carried out in the order written. The sequence of steps may be varied and still remain within the scope of the disclosure.

Furthermore, it will be appreciated that while the present disclosure provides embodiments having one or more of the features/characteristics discussed herein, one or more of these features/characteristics may also be disclaimed in other alternative embodiments and the present disclosure provides support for such disclaimers and these associated alternative embodiments.

DESCRIPTION OF EMBODIMENTS

Exemplary, non-limiting embodiments of a method of improving the shelf life of a food product and a food product with an improved shelf life are disclosed hereinafter.

In various embodiments, there is provided a method of improving the shelf life of a food product, e.g., fresh noodles, the method comprising, providing a food product comprising alginate; applying a treatment solution comprising a calcium source to the food product; and forming a coating of calcium alginate on an external/outer surface of the food product.

In various embodiments, the coating of calcium alginate has a substantially neutral pH. In various embodiments, the coating of calcium alginate is a thermo-irreversible coating. In various embodiments, the method may be carried out at a process pH that is kept/controlled within the range of from about 3 to about 8 to facilitate formation of the coating of calcium alginate. In various embodiments, the process pH may be controlled within the range with start and end points selected from the following group of numbers: 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, and 8.

In various embodiments, by treating a food product with the method as disclosed herein, the shelf life of the food product may advantageously be extended without substantially affecting organoleptic properties of the food product, e.g., taste, texture, color, and mouthfeel of fresh noodles. Advantageously, the shelf life of a treated food product may be from about 1 month to about 12 months at an ambient storage temperature of about 25°C to about 35°C. In various embodiments, the shelf life of the treated food product may fall in a range selected from the following group of numbers: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12 months. In various embodiments, the method may be capable of producing a food product, e.g., fresh noodles, with a shelf life of at

least about 6 months having better textural and/or organoleptic properties compared to conventional pasteurized noodles. In various embodiments, the treated food product (e.g., treated rice noodles) may, after a period of storage within the shelf life, have a quality (e.g., color characteristics, hardness, resilience, cohesiveness, springiness) that is within a range of ±15% as compared to the food product when freshly produced at day 0 without any heat treatment. In various embodiments, the food product treated with the treatment solution is substantially free of chemical preservatives. In various embodiments, the food product treated with the treatment solution is completely free of chemical preservatives. In various embodiments, the method is devoid of a step of applying a coating of oil on an external surface of the food product. In various embodiments therefore, the food product treated with the treatment solution is substantially free of an oil coating. Advantageously, the food product has decreased oiliness due to the absence of an oil coating.

In various embodiments, the organoleptic properties (e.g., taste, texture, color, and mouthfeel) of a treated food product may be compared/benchmarked with a control food product using quantitative parameters. In various embodiments, the treated food product to be used for comparison/benchmarking may undergo treatment by the presently disclosed method. In various embodiments, the treated food product to be used for comparison/benchmarking may be packaged and pasteurized/sterilized. In various embodiments, the treated food product to be used for comparison/benchmarking may be kept at an ambient storage temperature of about 25°C to about 35°C for a certain period of time falling within the range of from about 1 month to about 12 months (e.g., 6 months). In various embodiments, the control food product may be a freshly produced food product at day 0 without any heat treatment. In various embodiments, the control food product may be a freshly produced food product which is not treated by the presently disclosed method at day 0 and does not undergo any heat treatment. In various embodiments, the control food product has the most preferred sensory/organoleptic properties that are desired to be achieved by the presently disclosed method. In various embodiments, the treated food product is compared

with the control food product to determine how far the organoleptic properties deviate from a freshly produced food product, e.g., freshly produced rice noodles, at day 0 or hour 0 which is not subjected to heat treatment and sterilization.

In various embodiments, a quantitative parameter of a treated food product may differ from the quantitative parameter of a control food product by a percentage difference falling in the range of from about 0% to about 20%. In various embodiments, a quantitative parameter of a treated food product that differs within about 5% from the quantitative parameter of a control food product is considered “very good quality”. In various embodiments, a quantitative parameter of a treated food product that differs within about 5% to about 10% from the quantitative parameter of a control food product is considered “good quality”. In various embodiments, a quantitative parameter of a treated food product that differs within about 10% to about 15% from the quantitative parameter of a control food product is considered “OK quality” or “acceptable quality”. In various embodiments, a quantitative parameter of a treated food product that differs within about 15% to about 20% from the quantitative parameter of a control food product is considered “marginal acceptable quality”. In various embodiments, a quantitative parameter of a treated food product that differs by more than about 20% from the quantitative parameter of a control food product is considered “rejected quality”.

In various embodiments, the shelf life of a treated food product may be determined based on color characteristics of the treated food product. In various embodiments, colorimetric analysis may be performed on the treated food product using a colorimeter working in the L*a*b* color space. The L*a*b* color space uses three coordinates to define any particular color. The L* component measures lightness and is particularly well suited to the perceptions of the human eye. The value of L* lies in the range from 0, which corresponds to pure black, and 100, which corresponds to pure white. The a* component measures the color position between red / magenta and green, with negative values indicating green and positive values indicating magenta. The b* component measures the color

position between yellow and blue, with negative values indicating blue, while positive values indicating yellow. It will be appreciated that the color of a food product may change as it undergoes degradation over time. Accordingly, changes in the color of the food product over time can be estimated by the magnitude and changes in the magnitude of the components L*, a* and b*.

In various embodiments therefore, a treated food product that has been stored for 6 months at an ambient storage temperature of about 25°C to about 35°C may have an L* value that is within about 5%, about 10%, about 15%, or about 20% of an L* value measured from a control food product. In various embodiments, a treated food product that has been stored for 6 months at an ambient storage temperature of about 25°C to about 35°C may have an a* / b* value that is within about 5%, about 10%, about 15%, or about 20% of an a* / b* value measured from a control food product.

In various embodiments, the shelf life of a treated food product may be determined based on one or more textural properties of the treated food product. In various embodiments, textural properties of a food product may comprise hardness, resilience, cohesiveness, and springiness of the treated food product. In various embodiments, Texture Profile Analysis (TPA) may be used to evaluate textural properties of a food product. In various embodiments, TPA may provide a quantitative assessment of textural properties such as hardness, resilience, cohesiveness, and springiness. In various embodiments, textural properties of a treated food product after a certain period of storage (e.g., 6 months of storage under ambient storage temperature of about 25°C to about 35°C) may be compared with textural properties of a control food product. In various embodiments, quantified textural properties of a treated food product after a certain period of storage, e.g., 6 months of storage, may differ within about 5%, within about 10%, within about 15%, or within about 20% of quantified textural properties of a freshly produced food product at day 0 without any heat treatment.

In various embodiments, the treated food product may be substantially free of aerobic and anaerobic microbes, yeast, and mold based on the laboratory test results of a microbial test which may be accredited by relevant agency in a particular country of interest. In this context, “substantially free” refers to levels of the aerobic and anaerobic microbes, yeast, and mold that are below detectable limits of the microbial test used. In various embodiments, the treated food product, e.g., a rice noodle sample is subjected to heat treatment of core temperature of at least 90°C for 30 minutes. In various embodiments, microbial testing may be done by an external accredited laboratory by subjecting the samples to commercial sterility test of holding for 14 days at 35°C and/or 7 days at 55°C. In various embodiments, methods for testing the samples may include total aerobic plate count (method: MIC08, method reference: US FDA-BAM (Food and Drug Administration – Bacteriological Analytical Manual) 2001 Chapter 3), total anaerobic plate count (method: MIC08 B, method reference: US FDA-BAM 2001 Chapter 3 - Modified), and total yeast and mold count in food samples (method: MIC15, method reference: US FDA-BAM 2001 Chapter 18). In various embodiments, the methods for testing may have a limit of detection (LOD) of about 10 colony forming units per gram (CFU/g). In various embodiments, the treated food product may be substantially free of aerobic and anaerobic microbes, yeast, and mold after incubation for 14 days at 35°C and for 7 days at 55°C.

In various embodiments, the treated food product may be substantially devoid of foreign/ abnormal odor after 6 months of storage at an ambient storage temperature of about 25°C to about 35°C.

In various embodiments, the method may be implemented using existing equipment for manufacturing the food product, e.g., fresh noodles. For example, an equipment for manufacturing the food product may comprise a combination of the following component units: a mixer unit for mixing various ingredients for making the food product, e.g., flour, additives, water; a plurality of dispenser units for dispensing the various ingredients into the mixing unit; a heat treatment unit for heating, e.g., steaming of a slurry mixture; an extruder unit for extruding an

intermediate form of the food product, e.g., spherical dough, into a desired form, e.g., elongate form; a cutter unit for cutting the food product into its desired shape and size; a roller unit for brushing an additive onto the surface of the food product; a spray unit for spraying an additive onto the surface of the food product; an immersion unit for immersing the food product in a treatment solution; a conveyor unit for conveying the food product between different component units for processing; a packaging unit for packing the food product into packages; and the like. For example, an existing wet milling machine may be used to grind soaked rice to reach a suitable particle size for further processing. For example, an existing heat treatment machine may be used for in-packet pasteurization or sterilization of the food product, e.g., noodles. Advantageously, there may be no need for construction of new equipment or modification of existing equipment to facilitate implementation of the method as disclosed herein. For example, rice-based noodles are typically dipped in oil to form an oil coating thereon to prevent sticking of the noodles to one another. To implement the method as disclosed herein, the equipment used for dipping in oil may be used for applying the treatment solution comprising the calcium source. In various embodiments, the method may provide a relatively low-cost method of production due to the ease of integration into existing equipment and the relatively low cost of the raw materials for improving the shelf life of the food product. In various embodiments therefore, the food product may advantageously be marketed at a reasonable selling price.

In various embodiments, the calcium source, e.g., calcium ion source, in the treatment solution functions to react with the alginate in the food product upon contact to form the coating of calcium alginate on the external surface of the food product. In various embodiments, the treatment solution may comprise from about 0.5% (w/w) to about 2% (w/w) of calcium salt as the calcium source with respect to the total weight of the treatment solution. In various embodiments, the concentration of the calcium salt may fall in the range with start and end points selected from the following group of numbers: 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, 0.95, 1, 1.05, 1.1, 1.15, 1.2, 1.25, 1.3, 1.35, 1.4, 1.45, 1.5, 1.55, 1.6,

1.65, 1.7, 1.75, 1.8, 1.85, 1.9, 1.95, and 2% (w/w) with respect to the total weight of the treatment solution. In various embodiments, the calcium salt may be a natural or synthetic calcium salt. In various embodiments, the calcium salt may include, but is not limited to, calcium lactate, calcined calcium, calcium chloride, calcium carbonate, calcium hydroxide, calcium phosphate, and the like.

In various embodiments, the treatment solution may further comprise one or more additives for improving one or more properties of the food product. In various embodiments therefore, a coating of the one or more additives is formed on the external surface of the food product after the treatment solution comprising said one or more additives is applied thereon. It will be appreciated that the additives may be optional, and their inclusion depends on factors such as costs, and availability of the additives.

In various embodiments, the treatment solution may further comprise one or more acids. In various embodiments, the acid forms a coating on the external surface of the food product to reduce/decrease microbiological hazard by creating an unconducive environment for the growth of microbes. In various embodiments, the acid may function as a pH adjuster. In various embodiments, the acid is an edible acid, e.g., organic acid. In various embodiments, the treatment solution may further comprise from about 0.5% (w/w) to about 1.5% (w/w) of one or more acids with respect to the total weight of the treatment solution. In various embodiments, the concentration of the one or more acids may fall in the range with start and end points selected from the following group of numbers: 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, 0.95, 1, 1.05, 1.1, 1.15, 1.2, 1.25, 1.3, 1.35, 1.4, 1.45, and 1.5% (w/w) with respect to the total weight of the treatment solution. In various embodiments, the one or more acids may include, but are not limited to, lactic acid, acetic acid, ascorbic acid, citric acid, fumaric acid, glutamic acid, gluconic acid, hydrochloric acid, malic acid, succinic acid, tartaric acid, and the like. In various embodiments, the amount of acid used may be sufficiently high such that the coating of acid is effective in reducing/decreasing microbiological hazard. In various embodiments, the

amount of acid used is not excessive to avoid imparting an overly sour taste and to avoid impairing the texture of the food product. In various embodiments, the acid may not be directly added into a slurry mixture of the food product, e.g., rice slurry for making rice-based noodles. Typically, when excessive acid is added to the rice slurry, the texture of the rice noodles may be adversely affected. In various embodiments, the use of acids may not be required for a heat-sterilized food product, e.g., retorted noodles.

In various embodiments, the treatment solution may further comprise a soluble fiber. In various embodiments, the soluble fiber may be soy extract, e.g., soy fiber. In various embodiments, the soluble fiber functions to prevent sticking or clumping of the food product, e.g., noodles. In various embodiments, the treatment solution may further comprise from about 1% (w/w) to about 10% (w/w) of soluble fiber with respect to the total weight of the treatment solution. In various embodiments, the concentration of the soluble fiber may fall in the range with start and end points selected from the following group of numbers: 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, and 10% (w/w) with respect to the total weight of the treatment solution. In various embodiments, the soluble fiber is soluble in an aqueous solvent, e.g., water. In various embodiments, the soluble fiber is not soluble in oil.

In various embodiments, the food product may be rice-based noodles or wheat-based noodles. In various embodiments, the conditions required for making rice-based or wheat-based noodles are similar to what is currently practiced by the manufacturers, e.g., type of cultivar or rice used, soaking time, particle size of rice after wet milling etc. In various embodiments, the steps of producing the rice-based or wheat-based noodles may be similar except for the treatment step where the rice-based or wheat-based noodles are contacted with the presently disclosed treatment solution which is non-oil based, instead of coating with oil as currently practiced in the art.

In various embodiments, the step of providing the food product may comprise preparing a slurry mixture, e.g., rice slurry mixture. In various embodiments, the rice slurry mixture comprises rice, e.g., broken rice. In various embodiments, the rice may be aged or non-aged rice. In various embodiments, aged rice may be preferred over non-aged rice for preparing the rice slurry mixture, as aged rice may have a higher amylose content and a more suitable ratio of amylose to amylopectin as compared to non-aged rice. In various embodiments, the rice slurry mixture may consist of 1 part broken rice to 2 parts water. In various embodiments, the rice slurry mixture may further comprise one or more powdered starches. In various embodiments, one or more starches may be added with a suitable amount of water to ensure that the viscosity of the rice slurry mixture is within a desired range. Sources of the powdered starch may include, but are not limited to, rice, corn, wheat, sago and tapioca. In various embodiments, the step of preparing the rice slurry mixture may comprise soaking the rice in water for a duration in the range of about 5 hours to about 12 hours. In various embodiments, the step of preparing the rice slurry mixture may further comprise milling the soaked rice to obtain the rice slurry mixture. In various embodiments, the step of preparing the rice slurry mixture may further comprise sieving the rice slurry mixture to, for example, remove unwanted particles from the slurry mixture, control particle size distribution of the slurry mixture, and break up clumps of particles. In various embodiments, additives such as alginate, modified starch, STPP and water may be added to the rice slurry mixture. In various embodiments, after adding additives such as alginate, modified starch, STPP and water, the amount of rice in the rice slurry mixture may fall in the range of from about 40% (w/w) to about 80% (w/w), from about 45% (w/w) to about 75% (w/w), from about 50% (w/w) to about 70% (w/w), from about 55% (w/w) to about 65% (w/w), or from about 55% (w/w) to about 60% (w/w). For example, the amount of rice in the rice slurry mixture may be about 60% (w/w). In various embodiments, the rice slurry mixture may be mixed, e.g., using a mixer, to promote substantially even distribution of ingredients within the rice slurry mixture. For normal rice noodles used as a control for comparison with rice

noodles treated by the presently disclosed method, the rice slurry mixture without the additives is steamed to be made into noodles.

In various embodiments, the step of providing the food product may further comprise steaming the slurry mixture, e.g., rice slurry mixture to obtain one or more sheets of the fresh noodles, e.g., rice sheets. In various embodiments, the slurry mixture may be poured into a container with a substantially flat surface (e.g., tray, conveyor belt) prior to steaming. In various embodiments, the slurry mixture may be steamed at a temperature of about 100°C. In various embodiments, the slurry mixture may be steamed for a duration of about 1 minute to about 5 minutes. An example of a steamed-sheet type of fresh noodles is Kway Teow, i.e., rice-based noodles in the form of flat elongated strips.

In various embodiments, the step of providing the food product may comprise preparing a dough mixture. In various embodiments, the step of preparing the dough mixture may comprise mixing ingredients such as flour, e.g., rice flour, water, and oil. In various embodiments, the dough mixture may be mixed, e.g., using a mixer, to promote substantially even distribution of ingredients within the dough mixture. In various embodiments, the step of providing the food product may further comprise extruding the fresh noodles from an extruder attachment. In various embodiments, the dough mixture may be loaded into a container attached to the extruder attachment. Some examples of extruder-type of noodles include Laksa Noodles and Bee Hoon, where Laksa Noodles typically have a larger diameter than Bee Hoon.

In various embodiments, the step of preparing the rice slurry mixture or dough mixture may further comprise adding alginate and one or more additives to the rice slurry mixture or dough mixture. In various embodiments, the presence of alginate in the food product may improve the strength, e.g., tensile strength, of the food product. In various embodiments, the one or more additives may be used for improving one or more properties of the food product. It will be appreciated

that the additives may be optional, and their inclusion depends on factors such as costs, and availability of the additives.

In various embodiments, the step of preparing the rice slurry mixture or dough mixture may comprise adding from about 0.1% (w/w) to about 2% (w/w) of alginate with respect to the total weight of the rice slurry mixture or dough mixture. In various embodiments, the amount of alginate may fall in the range with start and end points selected from the following group of numbers: 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, 0.95, 1, 1.05, 1.1, 1.15, 1.2, 1.25, 1.3, 1.35, 1.4, 1.45, 1.5, 1.55, 1.6, 1.65, 1.7, 1.75, 1.8, 1.85, 1.9, 1.95, and 2% (w/w) with respect to the total weight of the rice slurry mixture or dough mixture. In various embodiments, the alginate may comprise sodium alginate or potassium alginate. In various embodiments, the alginate may be dispersed in another powder, e.g., other starches such as tapioca starch or modified starch, for improved solubility.

In various embodiments, the step of preparing the rice slurry mixture or dough mixture may further comprise adding from about 0.1% (w/w) to about 2% (w/w) of food-grade phosphate, e.g., pentasodium triphosphate (STPP) with respect to the total weight of the rice slurry mixture or dough mixture. In various embodiments, the amount of food-grade phosphate, e.g., pentasodium triphosphate (STPP) may fall in the range with start and end points selected from the following group of numbers: 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, 0.95, 1, 1.05, 1.1, 1.15, 1.2, 1.25, 1.3, 1.35, 1.4, 1.45, 1.5, 1.55, 1.6, 1.65, 1.7, 1.75, 1.8, 1.85, 1.9, 1.95, and 2% (w/w) with respect to the total weight of the rice slurry mixture or dough mixture. In various embodiments, the addition of STPP may advantageously improve binding of the noodles to prevent breakage. In various embodiments, the STPP may be replaced with other types of food-grade phosphates.

In various embodiments, the step of preparing the rice slurry mixture or dough mixture may further comprise adding a texturizing agent. Examples of

texturizing agents include but are not limited to modified starches, vegetable gums, pectin, gelatin, agar and carrageenan. In various embodiments, the step of preparing the rice slurry mixture or dough mixture may further comprise adding from about 5% (w/w) to about 15% (w/w) of one or more modified starches with respect to the total weight of the rice slurry mixture or dough mixture. In various embodiments, the amount of the one or more modified starches may fall in the range with start and end points selected from the following group of numbers: 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5, 13, 13.5, 14, 14.5, and 15% (w/w) with respect to the total weight of the rice slurry mixture or dough mixture. Examples of the modified starch include, but are not limited to, modified starches of a commercially available type, for example, bleached starch, soluble starch, crosslinked starch, esterified starch, etherified starch, esterified crosslinked starch, and etherified crosslinked starch. In various embodiments, the addition of one or more modified starches may advantageously improve binding of the food product to prevent breakage.

In various embodiments, the step of applying the treatment solution is not particularly limited as long as the food product can be brought into contact with the treatment solution, such that a layer or coating of the treatment solution is formed on the external surface of the food product. In various embodiments, the step of applying the treatment solution may comprise dipping a roller into the treatment solution and brushing the roller onto the food product, e.g., fresh noodles. In various embodiments, the step of applying the treatment solution may comprise immersing the food product in a bath of the treatment solution. In various embodiments, the step of applying the treatment solution may comprise spraying the treatment solution from a spraying attachment onto the food product. In various embodiments, the food product, e.g., fresh noodles in a pre-cut sheet form or final elongate form, may be transported on a conveyor unit and the roller or spraying attachment may be positioned along a path of movement of the food product on the conveyor system, such that the treatment solution is applied onto the food product as it passes the roller or spraying attachment.

In various embodiments, the food product is contacted with the treatment solution for a predetermined duration. In various embodiments, the food product may be contacted with the treatment solution once or multiple times. In various embodiments, each contact of the treatment solution with the food product is limited to a predetermined duration. In various embodiments, the predetermined duration of contact of the food product with the treatment solution may be no more than 5 seconds, no more than 10 seconds, no more than 15 seconds, no more than 20 seconds, no more than 25 seconds, no more than 30 seconds, no more than 35 seconds, no more than 40 seconds, no more than 45 seconds, no more than 50 seconds, no more than 55 seconds, or no more than 60 seconds (or 1 minute). In various embodiments, the predetermined duration of contact of the food product with the treatment solution may be no more than 60 seconds or no more than any of the aforementioned duration for the various methods of contact, including immersion, spraying, and brushing. In various embodiments, where the food product is contacted with the treatment solution for a plurality of times, the total duration of contact of the food product with the treatment solution may be no more than 60 seconds or no more than any of the aforementioned duration.

In various embodiments, the duration of contact with the treatment solution is sufficiently long such that a relatively thin layer of gel is formed on the outer surface of the food product. In various embodiments, the duration of contact with the treatment solution is not excessively long such that the food product becomes brittle and easily breaks into pieces. In various embodiments, when a relatively thin layer/coating of calcium alginate is formed on the outer surface of the food product, e.g., noodles, the layer/coating is always contacting the food product. In various embodiments, the soluble fiber and acid additives held in the relatively thin coating of calcium alginate are functional (i.e., intended to impart specific properties) to the food product, e.g., noodles. In various embodiments, the treatment solution may be prepared such that it contains a limited amount of calcium to form the thin coating around the food product, e.g., noodles, and the amount of treatment solution remaining on the food product after the 1-minute contact duration should be a residual amount. In various embodiments, there

should be no more treatment solution for further reaction to avoid causing the entire food product, e.g., noodles, to form a calcium alginate gel as the texture would be like brittle jelly.

In various embodiments, the method further comprises cutting the food product. In various embodiments, one or more sheets of the food product, e.g., rice sheets, are cut into elongate form, after applying the treatment solution. In various embodiments, the treatment solution may also be further applied to the cut food product e.g., to further coat newly exposed surfaces of the food product that have arisen from cutting. In some other embodiments, the treatment solution may be first applied to the food product only after it has been cut (i.e., the food product is one that is in a cut form) rather than before and after it has been cut.

In various embodiments, the method further comprises packaging the food product, e.g., fresh noodles, without rinsing to remove residual treatment solution. In various embodiments, rinsing of the food product to remove residual treatment solution may be optional.

In various embodiments, the method further comprises sterilizing or pasteurizing the food product, e.g., fresh noodles, after applying the treatment solution and forming the coating of calcium alginate. In various embodiments, the sterilization or pasteurization step may be performed after packaging and sealing the treated fresh noodles. In various embodiments, sterilizing or pasteurizing the food product may reduce the susceptibility of the food product to microbial spoilage. In various embodiments therefore, sterilizing or pasteurizing the food product may prolong the shelf life of the food product based on microbiological safety limit. In various embodiments, application of the treatment solution as disclosed herein to a food product comprising alginate may improve or preserve the organoleptic / sensory properties of the food product. In various embodiments, applying the treatment solution as disclosed herein to a food product comprising alginate, and sterilizing or pasteurizing the food product may

advantageously prolong the shelf life based on microbiological safety limit and improve or preserve the organoleptic properties of the food product.

In various embodiments, there is provided a food product with an improved shelf life, the food product comprising a coating of calcium alginate formed on an external surface thereof. In various embodiments, the food product further comprises one or more of the following ingredients: about 0.1% (w/w) to about 2% (w/w) of a food-grade phosphate, e.g., pentasodium triphosphate (STPP); about 5% (w/w) to about 15% (w/w) of a texturizing agent, e.g., modified starch; an acid; and a soluble fiber, e.g., soy fiber. In various embodiments, the modified starches and soy fiber may be substituted with another ingredient from the same category of function, for example replacing modified starches (as texturizing agent) with vegetable gums, pectin, gelatin agar or carrageenan.

BRIEF DESCRIPTION OF FIGURES

FIG. 1 is a schematic flowchart for illustrating a method of improving the shelf life of a food product, e.g., fresh noodles in an example embodiment.

FIG. 2 is a schematic block diagram of a noodle making equipment for manufacturing fresh rice-based noodles in an example embodiment.

FIG. 3 is a photograph showing a packet of rice-based noodles (also known as Kway Teow) in an example embodiment.

FIG. 4 is a photograph showing a side-by-side comparison of samples of rice-based noodles prepared using the presently disclosed method (right-hand side) and a control method (left-hand side) in an example embodiment.

FIG. 5 is a group of photographs showing a side-by-side comparison of samples of rice-based noodles prepared using the presently disclosed method and a control method in an example embodiment.

DETAILED DESCRIPTION OF FIGURES

Example embodiments of the disclosure will be better understood and readily apparent to one of ordinary skill in the art from the following discussions and if applicable, in conjunction with the figures. It should be appreciated that other modifications related to structural, chemical and material changes may be made without deviating from the scope of the invention. Example embodiments are not necessarily mutually exclusive as some may be combined with one or more embodiments to form new exemplary embodiments. The example embodiments should not be construed as limiting the scope of the disclosure.

FIG. 1 is a schematic flowchart (100) for illustrating a method of improving the shelf life of a food product, e.g., fresh noodles in an example embodiment. At step (102), a food product comprising alginate is provided. At step (104), a treatment solution comprising a calcium source is applied to the food product. At step (106), a coating of calcium alginate is formed on an external surface of the food product.

In the example embodiment, the method may be used for keeping steamed rice-based noodles fresh, using rice as the primary raw material, adding ingredients such as alginate, STPP and modified starches in conjunction with a treatment solution, e.g., dipping solution, containing calcium, lactic acid and soy fiber, and applying pasteurization or sterilization.

In the example embodiment, at step (102) of providing a food product comprising alginate, fresh rice-based noodles are prepared from the following raw materials by weight percent: 60% (w/w) of rice slurry, 9% (w/w) of modified starch, 0.3% (w/w) of sodium alginate and 0.3% (w/w) STPP, with the rest being water. The materials for making the rice-based noodles include broken rice and optionally, powdered starches such as rice, corn, wheat, sago and tapioca flour. First, the rice is soaked in water for about 5 to about 12 hours before being milled

to a slurry and sieved. Thereafter, the starch and additives such as alginate, STPP and modified starch(es) are added to the rice slurry and steamed to obtain rice sheets. In the example embodiment, there is a desired viscosity range for the rice slurry and additives prior to steaming. Rice slurry for making normal noodles (i.e., regular slurry) have a viscosity of about 60cP. However, when alginate is added, the viscosity of the rice slurry is increased to about 100cP, depending on the type of alginate added. Water can be added to adjust the viscosity of the rice slurry with additives, such that the viscosity is similar to that of the regular slurry. However, if excessive water is added, it may result in increased breakage of the rice-based noodles.

In the example embodiment, at step (104) of applying a treatment solution comprising a calcium source to the food product, the treatment solution comprises 0.8% (w/w) lactic acid, 1% (w/w) calcium lactate and 1.2% (w/w) soy fiber. The steamed rice sheets are subjected to immersion/dipping treatment with the treatment solution containing the acid, calcium source and soluble fiber, thereby forming a coating comprising calcium alginate on an external surface of the rice sheets. Subsequently, the treated rice sheets are cut into a desired size to form noodles and without rinsing, packaged and heated either by steaming or boiling pasteurized or retorted.

In the example embodiment, the use of only alginate in the rice slurry (i.e., step 102 of FIG. 1) without providing the treatment solution (i.e., step 104 of FIG. 1) results in rice noodles of poorer texture as compared to a control food product due to more water being added to achieve the same viscosity thus resulting in increased breakage.

Advantageously, by utilizing the method for the preparation of fresh rice-based noodles, the fresh wet rice-based noodle is characterized by a bright white translucent appearance and an elastic texture and has a shelf life of at least 6 months at ambient temperature (25°C to 35°C) without adding any chemical preservatives. In addition, the fresh wet rice-based noodle prepared by this

preparation method have the advantages of relatively low degree of mushiness, bright surface, relatively high elasticity with minimal breakage. The taste, texture, color and mouthfeel of the rice-based noodles are not substantially impaired by the preparation method. Moreover, the preparation method of the fresh noodles is simple and convenient to operate and is suitable for scale-up and incorporation into current factory equipment by substituting the oiling of the noodle with the treatment solution.

FIG. 2 is a schematic block diagram of a noodle making equipment (200) for manufacturing fresh rice-based noodles in an example embodiment. The noodle making equipment (200) may be an existing noodle making equipment currently used by food manufacturers.

In the example embodiment, the noodle making equipment (200) comprises a mixer unit (202) for mixing various ingredients such as alginate, STPP and modified starch(es), with the rice slurry for making the rice-based noodles. The mixer unit (202) comprises a plurality of dispenser units (204, 206) for dispensing the various ingredients into the mixer unit (202). The various ingredients may be pre-mixed separately with water before being dispensed through the dispenser units (204, 206).

In the example embodiment, the noodle making equipment (200) may be used to manufacture rice noodles with an alginate coating on the surface of the noodle strands. The presence of alginate improves the strength of the noodles. The alginate coating (with calcium) on the surface of the noodles has a neutral pH, is thermo-irreversible, and prevents sticking. In the example embodiment, additional water may be added into the formulation to achieve a low viscosity formulation. In the example embodiment, alginate powder may be dispersed into another powder for improved solubility.

In the example embodiment, the noodle making equipment (200) may be used to manufacture rice noodles containing additives such as modified starches

and STPP. Modified starches may be added for improved binding to prevent breakage. Modified starches may have relatively low water binding in cool mixing, may be easy to disperse in water, and may have a neutral pH.

In the example embodiment, the noodle making equipment (200) further comprises a steamer unit (220) for steaming the rice slurry mixture, to obtain a continuous sheet of the fresh noodles, e.g., rice sheets. The steamer unit (220) may comprise a substantially flat surface (e.g., tray) for holding the rice slurry mixture during steaming. The rice slurry mixture may be steamed at a temperature of about 100°C for a duration of about 1 minute to about 5 minutes.

In the example embodiment, the noodle making equipment (200) further comprises a conveyor unit (208) configured to convey/transport the steamed rice sheet (214) along a direction of movement indicated by the block arrow to different components of the noodle making equipment (200) for further processing.

In the example embodiment, the noodle making equipment further comprises a roller unit (210). In the current state of the art, the roller unit (210) is used for applying a coating of oil onto the external surface of the rice sheet (214). The roller unit (210) is dipped into a container (216) containing oil (i.e., oil bath) and thereafter the roller unit (210) is used to brush the oil onto the rice sheet (214). A dispenser (218) that is positioned in the vicinity of, e.g., above the container (216) is configured to dispense oil into the container (216) to replenish the oil therein.

In the example embodiment, the roller unit (210) may be reconfigured to apply the treatment solution instead of oil onto the external surface of the rice sheet (214). The roller unit (210) may be dipped into the container (216) containing the treatment solution and thereafter the roller unit (210) is used to apply the treatment solution onto the rice sheet (214) to form the coating of calcium alginate thereon. The dispenser (218) may be reconfigured to dispense

the treatment solution into the container (216) to replenish the treatment solution therein. The treatment/coating solution for formed noodles may comprise an acid, e.g., lactic acid, a calcium source, e.g., calcium lactate, and a soluble fiber, e.g., soy fiber. The calcium source functions to form the calcium alginate gel on the surface of the noodles. The acid functions to provide a coating on the surface of the noodles to decrease microbiological hazard without making it overly sour and to not affect texture of the noodles (not needed for retorted noodles). The soluble fiber further prevents sticking of noodles.

Advantageously, there are no special modifications of equipment needed to facilitate the preparation method of the noodles. The preparation method can be adopted with manufacturers' current equipment by changing the process flow. Currently normal rice-based noodles, such as kway teow, may be dipped in oil to prevent sticking. In place of oil dipping, the preparation method applies the treatment solution containing an acid, a calcium source, and soluble fiber. The equipment used for dipping in oil can be used for contacting the rice-based noodles with the treatment solution.

In the example embodiment, the noodle making equipment (200) further comprises a cutter unit (212) configured to cut the rice sheet (214) into elongated strips (222) of rice-based noodles after the coating of calcium alginate is applied.

FIG. 3 is a photograph showing a packet of rice-based noodles (also known as Kway Teow) in an example embodiment. After the rice-based noodles are cut into elongated strips, they are packaged, sealed, and heated either by pasteurization (either steaming or boiling) or heat sterilization. In the example embodiments, rice-based noodles treated by the presently disclosed method may be subjected to steaming.

FIG. 4 is a photograph showing a side-by-side comparison of samples of rice-based noodles prepared using the presently disclosed method (right-hand side) and a control method (left-hand side) in an example embodiment. The rice-

based noodles made using the control method appear fragmented and of a less consistent texture than the rice-based noodles made using the presently disclosed method.

FIG. 5 is a group of photographs showing a side-by-side comparison of samples of rice-based noodles prepared using the presently disclosed method and a control method in an example embodiment. The control method of preparing rice-based noodles refers to a method of preparing normal rice-based noodle known in the art. That is, rice slurry is steamed, cut, packaged and subjected to pasteurization or heat-sterilization. In the example embodiment, the samples are pasteurized to core temperature of at least 90°C for 30 minutes and kept for 2 months.

In the control sample, the rice-based noodles exhibit common issues faced after pasteurization/sterilization, such as sticking of noodle strands (due to starch leeching), breaking of noodle strands, unattractive appearance due to a coating of oil and dull color. As compared to the control sample (left side in FIG. 4 and left side in FIG. 5), the rice-based noodles prepared using the presently disclosed method (right side in FIG. 4 and right side in FIG. 5) exhibit decreased stickiness, improved noodle strength, improved brightness, and decreased cooking loss. There is also no need to apply oil to the rice-based noodles prepared using the presently disclosed method. The inventor anticipate that the presently disclosed method may lead to lower costs of production of rice-based noodles due to its ease of integration into existing equipment (e.g., replacement of oil coating with a treatment solution of an acid, a calcium source, and soluble fiber), and lower requirement for raw materials (e.g., it may be possible to not use aged rice which can be more costly as compared to non-aged rice).

EXAMPLES

Example 1:

Noodles prepared using a conventional/traditional method and the presently disclosed method were compared to control food product (untreated and unpasteurized rice noodles that are freshly produced at 0h) based on their color and texture.

Fresh rice noodles (Kway Teow) were prepared based on the conventional method. 1.5kg of broken rice (RVA Rice Setback value of 1390) was washed, then soaked in 1.5kg of distilled water for 18 hours. 1.5kg of additional distilled water (10°C) was added before milling to form a homogenized slurry that passed through a 250μm size sieve.

For Comparative Example 1, 0.15% (w/w) of lactic acid was added into the rice slurry for a final pH of 4.5 before steaming for 2 minutes, oiled, and cut into 4cm width strips, and packed in 200g units.

For Inventive Example 1, 0.33% (w/w) medium viscosity sodium alginate, 8.9% (w/w) acetylated distarch phosphate (modified starch), 0.27% (w/w) pentasodium triphosphate and 31% (w/w) additional water were added into the rice slurry before steaming for 2 minutes. The steamed rice sheet was dipped into the treatment solution comprising 1% (w/w) calcium lactate, 1.2% (w/w) soluble soy polysaccharide, and 0.8% (w/w) lactic acid in water, for less than 1 minute, then cut into 4cm width strips and packed in 200g units.

All the resulting packed rice noodles of Comparative Example 1 and Inventive Example 1 were subsequently steamed at 100°C to obtain a core temperature of at least 90°C for 30 minutes. After storage at 25°C, 80% humidity for 2 months, the rice noodles were analyzed for their color and texture according to the analytical methods below.

Analytical Methods

Color Measurement – A chroma meter (KONICA MINOLTA Spectrophotometer CM-5, Japan) using the CIE 1976 L*, a* and b* color scale, was used to measure the color of the noodles. L* measures brightness (0-100), a* represents the red - green coordinates (- is green with + indicating redness) while b* measures the blue - yellow coordinates (- is blue with + indicating yellowness) of a product. At least 3 measurements were carried out for each sample.

Texture Analysis – Texture properties of noodles were measured using TA.XT PLUS C Texture Analyzer (Stable Micro Systems, UK) equipped with a 30-kg load cell under optimal test conditions. Texture profile analysis (TPA) in a double compression cycle of noodle samples was conducted using a TA-47 pasta blade. The following settings were used: test speed: 5 mm/s, post-test speed: 5 mm/s; strain: 75%; trigger force of 5 g; time between compressions: 3 seconds and with starting height: 10 mm. From the TPA curve, hardness (maximum peak force during the first compression), resilience (ratio between the area under the first compression curve to reach the peak and the area under the first compression curve after the peak), cohesiveness (ratio between the area under the second peak and the area under the first peak), springiness (ratio between recovered height after first compression and the noodle height), and chewiness (product of hardness, cohesiveness and springiness) of the noodles were reported. Each test was performed on 1 strand of 4cm width noodle and at least 10 tests were performed for each variant.

Results

Table 1 – Color and hardness data of rice-based noodles

	L* (D65)	a* (D65)	b* (D65)	Hardness (g)	Resilience %	Cohesion	Springiness %
Comparative Example 1	65.17 ± 0.35[a]	-2.57 ± 0.16[a]	-4.04 ± 0.29[a]	1636.36 ± 204.34[a]	16.88 ± 5.52[a]	0.26 ± 0.06[a]	78.38 ± 12.15[a]

(2 months)							
Inventive Example 1 (2 months)	59.88 ± 0.27[b]	-2.10 ± 0.06[b]	-6.31 ± 0.10[b]	1483.74 ± 80.40[b]	32.29 ± 6.44[b]	0.43 ± 0.04[b]	99.96 ± 9.92[a]

Different letters represent statistically significant differences (P≤0.05) for each attribute.

For texture, Inventive Example 1 has lower hardness, with higher resilience and cohesiveness compared to Comparative Example 1. For color, Inventive Example 1 is less yellow than Comparative Example 1.

Example 2:

Fresh rice noodles (Kway Teow) were prepared based on the conventional method similar to Example 1, except that in this Example, broken rice of RVA Rice Setback value of 567 was used to prepare the control and examples.

Comparative Example 2 was prepared in a similar manner as Comparative Example 1 except that an additional 6.5% (w/w/) wheat starch and 6.5% (w/w/) water were added to the rice slurry besides 0.15% (w/w/) of lactic acid. The use of additional wheat starch and additional water in Comparative Example 2 was to account for the difference in RVA Rice Setback value as compared to Comparative Example 1.

Inventive Example 2 was prepared in a similar manner as Inventive Example 1.

All the resulting packed rice noodles of Comparative Example 2 and Inventive Example 2 were subsequently steamed at 100°C to obtain a core temperature of at least 90°C for 30 minutes. After storage at 25°C, 80% humidity for 6 months, the rice noodles were analyzed for their color and texture according to the analytical methods of Example 1.

Results

Table 2 – Color and hardness data of rice-based noodles

	L* (D65)	a* (D65)	b* (D65)	Hardness (g)	Resilience %	Cohesion	Springiness %
Comparative Example 2 (6 months)	62.90 ± 1.19[a]	-2.52 ± 0.18[a]	-3.06 ± 0.29[a]	1189.03 ± 173.67[a]	12.62 ± 2.78[a]	0.18 ± 0.02[a]	57.73 ± 10.53[a]
Inventive Example 2 (6 months)	59.70 ± 1.08[b]	-2.27 ± 0.14[b]	-4.82 ± 0.25[b]	1120.34 ± 50.73[a]	23.27 ± 5.89[b]	0.38 ± 0.06[b]	96.08 ± 7.88[b]

Different letters represent statistically significant differences (P≤0.05) for each attribute

For texture, Inventive Example 2 has more resilience, cohesiveness, springiness than Comparative Example 2. For color, Inventive Example 2 is less yellow than Comparative Example 2.

Example 3:

Fresh rice noodles (Kway Teow) were prepared based on the conventional method similar to Example 1, except that in this Example, broken rice of RVA Rice Setback value of 567 was used to prepare the control and examples.

Comparative Example 3 was prepared in a similar manner as Comparative Example 1 except that an additional 6.5% (w/w/) wheat starch and 6.5% (w/w/) water were added to the rice slurry besides 0.15% (w/w/) of lactic acid. The use of additional wheat starch and additional water in Comparative Example 3 was to account for the difference in RVA Rice Setback value as compared to Comparative Example 1.

Inventive Example 3 was prepared in a similar manner as Inventive Example 1.

For Comparative Example 4 (“alginate only”), 0.35% (w/w/) medium viscosity sodium alginate, 4.9% (w/w/) wheat starch and 29.4% (w/w/) additional water were added into the rice slurry before steaming for 2 minutes. The steamed rice sheet was dipped with the treatment solution of 1% (w/w/) calcium lactate, 1.2% (w/w/) soluble soy polysaccharide, and 0.8% (w/w/) lactic acid in water, for less than 1 minute, then cut into 4cm width strips and packed in 200g units.

For Comparative Example 5 (“modified starch and pentasodium triphosphate only”), 9% (w/w/) acetylated distarch phosphate (modified starch), 0.26% (w/w/) pentasodium triphosphate, 8.7% (w/w/) additional water and 0.14% (w/w/) of lactic acid were added into the rice slurry for a final pH of 4.5 before steaming for 2 minutes, oiled, and cut into 4cm width strips, and packed in 200g units.

All the resulting packed rice noodles of Comparative Examples 3, 4 and 5 and Inventive Example 3 were subsequently steamed at 100°C to obtain a core temperature of at least 90°C for 30 minutes. After storage at 30°C, 80% humidity for 1, 2, 3 and 4 weeks, the rice noodles were analyzed for their color and texture according to the analytical methods of Example 1.

Comparative Examples 3 to 5 and Inventive Example 3 were prepared according to the formulations listed in Table 3 below:

Table 3

Ingredients (w/w)	Comparative Example 3	Inventive Example 3	Comparative Example 4	Comparative Example 5
Homogenized slurry	87%	59%	65%	82%
Sodium alginate	0.00%	0.33%	0.35%	0%

Wheat starch	6.50%	0%	4.90%	0%
Modified Starch	0%	9%	0%	9%
Pentasodium triphosphate	0.00%	0.27%	0%	0.26%
Lactic acid	0.14%	0%	0%	0.14%
Water	6.50%	31%	29.40%	8.70%
After steaming for 2 min:	Oil	Treatment solution	Treatment solution	Oil

Quality is defined according to the criteria listed in Table 4:

Table 4

Criteria	Quality
Within 5% of control rice noodles parameters	Very good
Within 5-10% of control rice noodles parameters	Good
Within 10-15% of control rice noodles parameters	Acceptable
Within 15-20% of control rice noodles parameters	Marginal
More than 20% difference from control rice noodles parameters	Rejected

Results

Table 5 – Texture data of rice-based noodles

Hardness					
	Week 0	Week 1	Week 2	Week 3	Week 4
Comparative Example 3	Acceptable	Good	Rejected	Good	Rejected
Inventive Example 3	Acceptable	Good	Marginal	Acceptable	Marginal
Comparative Example 4	Good	Good	Marginal	Marginal	Rejected
Comparative Example 5	Acceptable	Rejected	Rejected	Rejected	Rejected

Resilience					
	Week 0	Week 1	Week 2	Week 3	Week 4
Comparative Example 3	Rejected	Acceptable	Rejected	Rejected	Rejected
Inventive Example 3	Acceptable	Rejected	Very good	Very good	Good
Comparative Example 4	Rejected	Rejected	Rejected	Rejected	Rejected
Comparative Example 5	Rejected	Rejected	Very good	Acceptable	Very good

Cohesion					
	Week 0	Week 1	Week 2	Week 3	Week 4
Comparative Example 3	Rejected	Acceptable	Rejected	Rejected	Rejected
Inventive Example 3	Very good	Good	Acceptable	Good	Good
Comparative Example 4	Rejected	Rejected	Rejected	Rejected	Rejected
Comparative Example 5	Marginal	Acceptable	Good	Very good	Acceptable

Springiness					
	Week 0	Week 1	Week 2	Week 3	Week 4
Comparative Example 3	Very good	Very good	Rejected	Marginal	Rejected
Inventive Example 3	Very good	Good	Very good	Very good	Very good
Comparative Example 4	Very good	Very good	Marginal	Acceptable	Rejected
Comparative Example 5	Very good	Very good	Very good	Very good	Very good

Table 6 – Color data of rice-based noodles

L* value					
	Week 0	Week 1	Week 2	Week 3	Week 4
Comparative Example 3	Acceptable	Acceptable	Marginal	Marginal	Acceptable
Inventive Example 3	Good	Good	Good	Good	Good
Comparative Example 4	Marginal	Marginal	Marginal	Marginal	Marginal
Comparative Example 5	Good	Good	Good	Acceptable	Good

a* value					
	Week 0	Week 1	Week 2	Week 3	Week 4
Comparative Example 3	Very good	Very good	Good	Good	Very good
Inventive Example 3	Very good	Good	Very good	Very good	Good
Comparative Example 4	Good	Very good	Very good	Very good	Very good
Comparative Example 5	Marginal	Good	Acceptable	Marginal	Acceptable

b* value					
	Week 0	Week 1	Week 2	Week 3	Week 4
Comparative Example 3	Marginal	Marginal	Rejected	Rejected	Rejected
Inventive Example 3	Good	Good	Good	Good	Good
Comparative Example 4	Marginal	Marginal	Marginal	Marginal	Rejected
Comparative Example 5	Rejected	Rejected	Rejected	Rejected	Rejected

For rice noodles, it may not be sufficient to have better performance in one property alone, the overall performance of all the properties needs to be considered. In general, the results demonstrate that the textural and color properties of Inventive Example 3 are better than Comparative Examples 3 to 5.

APPLICATIONS

Embodiments of the methods disclosed herein provide an effective and low-cost method of improving the shelf life of a food product. Embodiments of the disclosed methods also seek to overcome the problems of limited shelf life of fresh food products and impaired organoleptic properties of the fresh food products after being stored over a period of time.

Advantageously, by treating a food product with the method as disclosed herein, the shelf life of the food product may advantageously be extended without substantially affecting organoleptic properties of the food product, e.g., taste, texture, color, and mouthfeel of fresh noodles. In addition, the method of

treatment as disclosed herein may advantageously extend the shelf life of the food product without using chemical preservatives. Further, the method of treatment as disclosed herein may advantageously produce a food product, e.g., rice-based noodles with lower fat content, as the food product is substantially free of an oil coating. Consequently, a food product treated by the method as disclosed herein may advantageously present a healthier food choice over its counterparts produced by existing methods known in the art.

Even more advantageously, there are no special modifications of equipment needed to facilitate the method as disclosed herein. The preparation method can be adopted with manufacturers' current equipment by changing the process flow. In addition, there may be potential material cost savings, as the raw materials used in the presently disclosed method may be cheaper as compared to their counterparts used in existing methods known in the art. For example, the combined use of ingredients like acids, calcium salt and soluble fiber in the treatment solution may be cheaper as compared to use of cooking oil for coating rice-based noodles, especially in seasons of soaring global cooking oil prices. Consequently, the presently disclosed method may provide a cost-effective method of improving shelf life of a food product.

It will be appreciated by a person skilled in the art that other variations and/or modifications may be made to the embodiments disclosed herein without departing from the spirit or scope of the disclosure as broadly described. For example, in the description herein, features of different exemplary embodiments may be mixed, combined, interchanged, incorporated, adopted, modified, included etc. or the like across different exemplary embodiments. The present embodiments are, therefore, to be considered in all respects to be illustrative and not restrictive.

CLAIMS

1. A method of improving the shelf life of a food product, the method comprising,

providing a food product comprising alginate;

applying a treatment solution comprising a calcium source to the food product; and

forming a coating of calcium alginate on an external surface of the food product.

2. The method according to claim 1, wherein the food product further comprises from 0.1% (w/w) to 2% (w/w) of a food-grade phosphate.

3. The method according to claim 1 or 2, wherein the food product further comprises from 5% (w/w) to 15% (w/w) of at least one modified starch.

4. The method according to any one of claims 1 to 3, wherein the treatment solution further comprises from 0.5% (w/w) to 1.5% (w/w) of an acid.

5 The method according to any one of claims 1 to 4, wherein the treatment solution further comprises from 1% (w/w) to 10% (w/w) of a soluble fiber.

6. The method according to any one of claims 1 to 5, wherein the treatment solution further comprises from 0.5% (w/w) to 2% (w/w) of calcium salt as the calcium source in the treatment solution.

7. The method according to any one of claims 1 to 6, wherein the step of providing the food product comprises steaming a slurry mixture to obtain one or more sheets of the food product.

8. The method according to claim 7, further comprising cutting the one or more sheets into elongate form, after applying the treatment solution and forming the coating of calcium alginate.

9. The method according to any one of claims 1 to 6, wherein the step of providing the food product comprises extruding fresh noodles from a dough via an extruder.

10. The method according to any one of claims 1 to 9, wherein applying the treatment solution comprises dipping a roller into the treatment solution and brushing the roller onto the food product; or immersing the food product in the treatment solution.

11. The method according to any one of claims 1 to 9, wherein applying the treatment solution comprises spraying the treatment solution from a spraying attachment onto the food product.

12. The method according to any one of claims 1 to 11, wherein applying the treatment solution comprising a calcium source to the food product comprises contacting the fresh noodles with the treatment solution for a duration of no more than 1 minute.

13. The method according to any one of claims 1 to 12, further comprising packaging the food product without rinsing to remove residual treatment solution.

14. The method according to any one of claims 1 to 13, further comprising pasteurizing or sterilizing the food product in a package, after applying the treatment solution and forming the coating of calcium alginate.

15. The method according to any one of claims 1 to 14, wherein the food product comprises rice-based noodles or wheat-based noodles.

16. The method according to any one of claims 1 to 15, wherein the food product has a shelf life of at least 6 months at ambient temperature of 25°C to 35°C.

17. The method according to any one of claims 1 to 16, wherein the food product treated with the treatment solution is substantially free of chemical preservatives.

18. The method according to any one of claims 1 to 17, wherein the food product treated with the treatment solution is substantially free of oil coating.

19. A food product with an improved shelf life, the food product comprising,

a coating of calcium alginate formed on an external surface thereof.

20. The food product according to claim 19, further comprising one or more of the following ingredients:

0.1% (w/w) to 2% (w/w) of pentasodium triphosphate (STPP);

5% (w/w) to 15% (w/w) of modified starch;

an acid; and

a soluble fiber.