

ENCAPSULATED FOOD CONTAINING DUNALIELLA ALGAE AND
PROCESS FOR THE PRODUCTION THEREOF

The present invention relates to encapsulated food containing Dunaliella algae and processes for the production thereof. More particularly, the present invention relates to encapsulated food obtained by
5 utilizing various kinds of active components present in Dunaliella algae, especially β -carotene present in the algae without destroying it, as well as to a process for producing such food.

Chlorella algae, which belong to the species of
10 unicellular Chlorophyceae, have been used to prepare food additives or health food in the form of a tablet by utilizing extracted solution from or dried powder of the algae. Dunaliella algae produce a lot of β -carotene therein when grown in a culture fluid containing a high
15 concentration of saline and a small amount of nitrogen under intense sunlight and other appropriate conditions. Natural β -carotene derived from Dunaliella algae has been utilized in the form of a suspension in vegetable oil as a natural coloring agent for food, cosmetics or feed, as
20 additives in health food or as material regulating vital functions, such as a nourishing diet supplement. However, no practical proposal has been made concerning a method of fully utilizing Dunaliella algae per se for health-oriented food without destroying β -carotene.

25 Dunaliella algae contain proteins, lipids, sugars, mineral matters such as iron and calcium, vitamins such as provitamin A and vitamin B group compounds and a variety of other physiologically active ingredients. Among these nutrients, β -carotene, a provitamin A group compound, is
30 easily oxidizable because it contains conjugated double bond chains. This presents a serious problem in the manufacture of health food containing Dunaliella algae. It has therefore been strongly desired to develop a method by

which the algae can be processed without destroying natural β -carotene and the product obtained can also be preserved in a stable state.

According to the invention there is provided a
5 lighttight hard capsule containing food which comprises a granular composition, the granular composition being obtainable by mixing from 15 to 50 parts by weight of a cyclodextrin with 100 parts by weight of Dunaliella algae in dried powder form to form a mixture and then mixing from
10 0.10 to 0.25 parts by weight of an antioxidant and from 35.4 to 40.6 parts by weight of a binder with 100 parts by weight of said mixture. A lubricant may optionally be present in the mixture, for example 100 parts by weight of the mixture may additionally comprise from 3.50 to 4.50
15 parts by weight of a lubricant.

The invention further provides a process for producing a lighttight hard capsule containing food which comprises Dunaliella algae, which process comprises

adding from 15 to 50 parts by weight of
20 cyclodextrin to 100 parts by weight of a dried powder of the algae and blending the two to form a mixture;

adding to 100 parts by weight of the mixture from 0.1 to 0.25 parts by weight of an antioxidant and from 35.50 to 40.6 parts by weight of a binder and blending
25 these materials;

granulating the resulting binder-containing mixture; and

encapsulating the resulting granules thus formed in a hard capsule which is not transparent to light.

30 Three hundred parts by weight of said granules may typically be encapsulated in a single capsule.

The invention also provides a lighttight soft capsule containing food which comprises a suspension in which 300 parts by weight of the suspension comprise from 10 to 240 parts by weight of Dunaliella algae in dried powder form, from 10 to 260 parts by weight of at least one of an animal or vegetable oil, from 1 to 10 parts by weight of a natural wax, from 1 to 10 parts by weight of an emulsifier and from 1 to 10 parts by weight of an antioxidant. Water may be added to the mixture before encapsulation, producing first an emulsion and then an emulsified suspension after addition of algae, oil and antioxidant.

Additionally, the invention provides a process for producing a lighttight soft capsule containing food which comprises Dunaliella algae, which comprises:

blending from 1 to 10 parts by weight of a natural wax, from 1 to 10 parts by weight of an emulsifier to form a mixture;

adding to the mixture thus formed from 10 to 240 parts by weight of the algae in dried powder form, from 10 to 260 parts by weight of at least one of an animal or vegetable oil and from 1 to 10 parts by weight of an antioxidant;

stirring these materials to form a suspension; and encapsulating the suspension thus formed in a soft capsule which is not transparent to light.

β -carotene is present in the resulting encapsulated food in a stable condition.

The invention seeks to provide a process for producing soft-capsuled food containing Dunaliella algae wherein stirring and treatments to obtain a suspension of Dunaliella algae and encapsulating treatments of the suspension are carried out in the absence of air so as not to destroy β -carotene present in the algae. For example, the stirring treatment to form a suspension may be carried

out in vacuo, and the suspension may be encapsulated in a soft capsule in the presence of an inert gas.

The dried powder of Dunaliella algae used as a starting material in the present invention means such powder as is obtained by the following steps:

- (1) preliminarily removing about 50% by weight of water gradually from the culture fluid of Dunaliella algae by a dehydrator such as a centrifuge so as to make it easier to dry the fluid;
- (2) adding to the dehydrated culture fluid a right amount each of an anticaking agent, preferably dextrin, an antioxidant, preferably vitamin E, and other suitable additives and
- (3) spray-drying, vacuum-drying or freeze-drying the mixture thus prepared.

Dunaliella algae are morphologically characterized by the absence of a hard cell wall composed of polysaccharides though the algae have a thin cell membrane, whereas the other green algae, such as Chlorella algae, have both a cell wall and a cell membrane. It is also characteristic of Dunaliella algae that they contain a large amount of β -carotene. Typical examples of Dunaliella employed in the present invention include Dunaliella bardawil and Dunaliella salina.

In accordance with the present invention, in the case of hard-capsuled food, dried powder of Dunaliella algae and cyclodextrin are mixed in an amount ranging from 15 to 50 parts by weight per 100 parts by weight of the former. The ratio of each other additive material per 100 parts by weight of the mixture is as follows:

a lubricant	3.50 - 4.50 parts by weight
(optionally added)	
an antioxidant	0.10 - 0.25 parts by weight
a binder	35.50 - 40.60 " " "

5 A typical hard capsule contains 300 parts by weight
(for example, 300 mg) of encapsulated granules. The
maximum content of dried powder of Dunaliella algae is 64%.
From the viewpoint of health, it would be desirable to eat
two or three capsules of the granulated food containing
10 Dunaliella algae a day. Especially if the food contains a
large amount of β -carotene, its full usefulness can be
secured.

 In the case of soft-capsuled food, prepared
suspension to be encapsulated in soft capsules may include
15 the following ingredients per capsule;

	Natural wax	1 - 10 parts by weight
	Emulsifier	1 - 10 " " "
	Dried powder of	
	Dunaliella algae	10 - 240 " " "
20	At least one animal or	
	vegetable oil	10 - 260 " " "
	<u>Antioxidant</u>	<u>1 - 10 " " "</u>
	Total suspension	300 parts by weight

25 A typical soft capsule contains 300 parts by weight
(for example, 300 mg) of encapsulated suspension. The
maximum content of the dried powder is 80%. It would be
fully good for health to eat two or three capsules of the
suspension food containing Dunaliella algae.

30 Examples of suitable antioxidants which can be used
in the present invention include vitamin C and vitamin E.
Among suitable binders are, for example, sugars, preferably
maltose. Examples of lubricants include talc and
preferably esters formed by reaction of sucrose with fatty
35 acid. Examples of cyclodextrin (the term cyclodextrin is

hereafter referred to as "CD") include α -CD, β -CD, γ -CD.

Examples of animal or vegetable oil which can be used in the soft-capsuled food include corn oil, palm oil and olive oil. Examples of natural wax include lanolin and yellow bees wax. Examples of an emulsifier include an ester of glycerin with a fatty acid such as a monoglyceride.

The viscosity of a suspension is advantageously 7000 - 8000 cps; that of an emulsified suspension is advantageously about 2000 cps.

Example 1

To 100 parts by weight of dried powder of Dunaliella algae was added 25 parts by weight of cyclodextrin and both were blended by a Model-V mixer for about five minutes. To 100 parts by weight of the resultant mixture were added 0.2 parts by weight of vitamin E as an antioxidant and 37 parts by weight of dried thick malt syrup of maltose as a binder to form a mixture. The mixture thus obtained was granulated into fine particles by a roller converter and the resultant granules were encapsulated in lighttight hard capsules to obtain the product. It was confirmed that the content of dried powder of Dunaliella algae in encapsulated food in a hard capsule was about 58.3%.

Example 2

10 mg of monoglyceride and 10 mg of yellow bees wax were stirred at a temperature of about 60°C for about fifteen minutes to obtain a mixture (2000 cps).

The resultant mixture, 100 mg of dried powder of Dunaliella algae, 2 mg of vitamin E and 178 mg of corn oil were stirred by a vacuum emulsifying machine or a pudding mixer at 700 rpm and then were further stirred by a homogenizing mixer at 100 rpm to form a suspension. The

suspension was encapsulated by the usual method in the presence of nitrogen gas in soft capsules which were made of soft gelatin capsule base colored with caramel in order to obtain products of soft-capsuled food.

- 5 The present invention has made it practicable to obtain novel encapsulated health food containing active ingredients of Dunaliella algae without destroying β -carotene in the dried powder of the algae or gradually, ^{or} diminishing the β -carotene content. In other words, the ^{ing} present invention has produced remarkably good results, ^{ins} utilizing naturally occurring β -carotene while keeping its activity and such results could not be attained by the prior art.
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CLAIMS

1. A lighttight hard capsule containing food which comprises a granular composition, the granular composition being obtainable by mixing from 15 to 50 parts by weight of
5 a cyclodextrin with 100 parts by weight of Dunaliella algae in dried powder form to form a mixture and then mixing from 0.10 to 0.25 parts by weight of an antioxidant and from 35.4 to 40.6 parts by weight of a binder with 100 parts by weight of said mixture.
- 10 2. A capsule according to Claim 1 and substantially as hereinbefore described.
3. A lighttight soft capsule containing food which comprises a suspension in which 300 parts by weight of the suspension comprise from 10 to 240 parts by weight of
15 Dunaliella algae in dried powder form, from 10 to 260 parts by weight of at least one of an animal or vegetable oil, from 1 to 10 parts by weight of a natural wax, from 1 to 10 parts by weight of an emulsifier and from 1 to 10 parts by weight of an antioxidant.
- 20 4. A capsule according to Claim 3 and substantially as hereinbefore described.
5. A process for producing a lighttight hard capsule containing food which comprises Dunaliella algae, which process comprises adding from 15 to 50 parts by weight of
25 cyclodextrin to 100 parts by weight of a dried powder of the algae and blending the two to form a mixture;
adding to 100 parts by weight of the mixture from 0.1 to 0.25 parts by weight of an antioxidant and from 35.50 to 40.6 parts by weight of a binder and blending
30 these materials;
granulating the resulting binder-containing mixture; and
encapsulating the resulting granules thus formed in a hard capsule which is not transparent to light.



6. A process according to Claim 5 and substantially as hereinbefore described.

7. A process for producing a lighttight soft capsule containing food which comprises *Dunaliella* algae, which
5 comprises:

blending from 1 to 10 parts by weight of a natural wax, from 1 to 10 parts by weight of an emulsifier to form a mixture;

adding to the mixture thus formed from 10 to 240
10 parts by weight of the algae in dried powder form, from 10 to 260 parts by weight of at least one of an animal or vegetable oil and from 1 to 10 parts by weight of an antioxidant;

stirring these materials to form a suspension; and
15 encapsulating the suspension thus formed in a soft capsule which is not transparent to light.

8. A process according to Claim 7 in which the stirring treatment to form a suspension is carried out in vacuo.

9. A process according to Claim 7 and substantially as
20 hereinbefore described.

