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METHOD OF PRESERVING VEGETABLES, FRUITS, AND SIMILAR VEGETABLE FOOD BY DRYING AND BRIQUETTING

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Vegetables and fruits have since a long time ago been preserved by drying. Furthermore it is known, in view of the costs of packing and distribution to compress the dried product in such manner as to reduce the air interspaces between the individual parts of the food. At the same time it is thereby achieved that the food to a certain degree is protected against taking up or giving off moisture, loss of aromatic substances and attack by fungus and mustiness or the like. For instance, it has been customary after laying dried fruits, such as figs, apricots and dates into their packing material to subject the same to pressure therein. However, by such means a tolerably good preservation is obtained only in connection with fruits very rich in sugar.

It is further known to press meat extract which has been reduced to powder, with addition of common salt or other crystalline as well as powdery and flour-like substances into cubes or bodies of similar shapes. Beyond the powder-like base, other basic substance, also granular ingredients or ingredients in pieces, i. a. also dried vegetables in suitably chopped or cut form may be present in such mixtures. It is, however, the powdery basic mass as well as the meat extract and a possible content of salt which keep the mass together to solid pressed bodies.

For medical use, furthermore, highly dried and finely pulverized vegetables, such as spinage, have been pressed into small, compact and hard tablets or pills in which a part of the vitamin content of the raw material is preserved in durable form. Similar tablets or pills have also been manufactured as forage, generally however with higher or lower percentages of strongly binding substances, such as flour of blood.

These products are not suited as real food for human beings since upon softening the same with water they form a very little attractive sludge.

The present invention relates to a method of preserving such vegetables and fruits and similar vegetable food which in fresh state contain less than 20% dry substance, by a drying process followed by pressing the same into briquet form. This method according to the invention is characterized in that the dried material in cut or chopped or any other form of pieces or coarse grains or in whole state is pressed into briquets of an apparent specific gravity of at least 1.1, preferably 1.2 or more. By apparent specific gravity is meant the weight of the briquet in grams divided by the volume of the pressed body in cubic centimetres (ccm).

By a preservation carried out in this way a pressed body is obtained in which by softening the same in water, the starting material will again appear in the cut, chopped, piece-formed, granular or whole-form from which one started in the drying process as suitable for the material in question and as suitable for the consumer.

In prior experiments for the preservation of vegetables by drying and pressing the same it was found, particularly in cases where the power of coherence was sufficient therefor, that the material could be stocked and distributed as briquets, and that the material was not satisfactorily preserved since the vitamin content for instance was destroyed just as rapidly as in the corresponding non-briquetted dried material. One exception only constituted the above-mentioned tablets for medical use and in weights of one or a few grams; even if the manufacture of larger briquets from a similar pulverulent material should be within the limits of technical possibility, this is, as already mentioned, of no interest on account of the very little attractive form in softened condition.

The present invention is in the first place based upon the observation that it is possible, in materials of the kind and the form described and the preservation of which is aimed at, according to the invention to wholly or partially preserve the valuable constituents against oxidation by increasing the apparent specific gravity by pressing the material to more than 1.1.

In the case of a material containing a certain quantity of constituents, for instance C-vitamin, which may be destroyed by oxidation a preservation of these constituents may, for instance, be attained by preventing the access of air from outside to a material on the one hand and by bringing the material into a form on the other hand in which inherently not so much air is present that the said constituents could be damaged thereby. In pressing dried vegetables into briquet form the admission of air from outside may in a high degree be prevented by pressing the briquet in such a manner that its surface becomes smooth and tight, the last-named condition, i. e. sufficiently low content of air, has, however, previously not been sufficiently observed.

Through a simple calculation an idea may be obtained as to how much air a briquet of vegetable should be allowed to contain, when one wishes to preserve the content of the food for instance of C-vitamins (ascorbinic acid).

The molecular weight of ascorbinic acid is 176 and 1 atom of oxygen is consumed for the oxidation of 1 molecule of ascorbinic acid to dehydroascorbinic acid. For the oxidation of 1 gram ascorbinic acid consequently

$$\frac{1\times16\times22.4\times1000}{176\times32}=64 \text{ cubic centimetres}$$

oxygen or 300 ccm atmospheric air are consumed. Since 1 gram g ascorbinic acid is equal to 20,000 international units (I. U.) of C-vitamin, 1 ccm air can thus destroy 66 international units (I. U.).

As it has been found that by pressing vegetables dried up to about 80% dry substance by means of a surface pressure of more than 1000 kg/sqcm during more than 15 minutes using a matrix, the specific gravity of the briquet cannot be raised essentially over 1.40, such a briquet may be considered practically free from air and consequently said specific gravity then approaches the true specific gravity of the material. A briquet having the apparent specific gravity s contains consequently 100 $(1-s:1.40)$ % air.

A briquet from, for instance, 125 g spinage of the specific gravity 1.00 and 80% dry substance thus contains 29% or 125×0.29=36.3 ccm air which is sufficient for destroying 36.3×66=2400 I.U. C-vitamin.

Since spinage, as it can be reckoned with, contains in average 15,000 I.U. C-vitamin per 100 g dry substance and since it has been found by experiments that in adopting a drying process more than 20% thereof remain preserved in particularly favourable conditions only, such a briquet will contain on an average 15000×0.20=3000 I.U. per 100 g dry substance.

The above-mentioned briquet of 125 g just containing 125×0.80=100 g dry substance brings about the effect that the air quantity present in the briquet is sufficient to destroy not less than 80% of the C-vitamin content in the briquet.

Regarding the provitamins for A-vitamin the conditions are essentially different, since the content of these substances in vegetables and fruits according to weight is very low in comparison with the content of ascorbinic acid. For instance, spinage contains seldom more than 0.06 g β-carotine per 100 g dry substance and the oxygen consumption per gram of these substances is lower than in the oxidation of ascorbinic acid.

It has been possible by carfully performed series of experiments with briquets from dried spinage and different cabbages of a specific gravity of about 1.00 to ascertain that the content of C-vitamin and β-carotine in these briquets was not preserved better during a period of 6 months than in the corresponding dried, but not briquetted material. The loss in percentage for the β-carotine was, however, not essentially higher than that for C-vitamin.

Only at an apparent specific gravity of more than 1.10 preferably about 1.20 or more, the air quantity contained in the briquet is so small that thereby a preservation of the vitamin content and other oxidizable constituents (for instance aromatic substances) is warranted and the present invention has therefore primarily for its object to press briquets having such an apparent specific gravity. It has been found that thereby briquets are attained which in most cases are denser and better than briquets previously produced, even if it is possible to manufacture briquets being completely satisfactory in mechanical respect which after expansion upon ceasing of the pressing pressure have an apparent specific gravity lying below 1.0. Briquets from dried vegetables having an apparent specific gravity exceeding 1.10 are not known in the prior art.

For obtaining a briquet which upon said expansion still has an apparent specific gravity exceeding 1.10 it is necessary, however, to exercise such a pressure as to obtain the correspondingly higher apparent specific gravity.

In a long series of experiments it has now been found that by pressing briquets which upon expansion have a specific gravity higher than 1.10 generally higher pressure and/or longer periods of pressing are required than is suitable for the practical manufacture of such briquets in the industry. In some cases such a briquet cannot be obtained at all even if very high pressures and long pressing periods of time are used. For making possible the pressing of such briquets in using tolerably moderate pressures below 1000 kg/sqcm and in employing not too long pressing periods of time and further to make possible the manufacture in such cases where such process previously was impossible, certain measures have to be taken which also form an object of the present invention.

It has thus been found that for each material and each surface pressure there is an optimum content of dry substance by which a briquet of the highest specific gravity and the least expansion is obtained and that a higher pressure corresponds to a higher optimum content of dry substance at which a higher specific gravity is obtained than at any lower values of content of dry substance and pressure. This fact will be explained by the following example:

In a series of experiments medium-grained spinage freed from the coarser ribs was dried to the dry substance content referred to hereinbelow, whereupon the dried material was pressed in a hydraulic press with manual pump in matrices at different surface pressures during 5 seconds into flat rectangular briquets all weighing 125 g and having a base surface of 65 x 125 millimeters (mm). The table states the thickness of the briquets produced in this way in millimeters, measured immediately upon the pressing process.

Dry substance, per cent	Surface pressure in kg./sqcm.		
	250	500	1000
74	12.8	-------	-------
77	12.6	(*)	----
84	13.6	12.8	12.5
86	-------	11.9	11.4
89	14.9	13.1	11.8
93	-------	-------	12.5

* The material was pressed between matrix and plunger.

From the above table it is evident that the optimum content of dry substance for 250, 500 and 100 kg per sqcm was 77.86 (or somewhat lower) and 86 (or somewhat higher) respectively. These dry briquets expanded all in 48 hours about 1.3 mm and from the thickness after expansion the loss in C-vitamin can be calculated in the manner mentioned above provided that the briquet as assumed contains 2400 I. U. per 100 gram dry substance:

Surface pressure in kg/sqcm	250	500	1,000
Thickness after expansion	13.9	13.2	12.7
Specific gravity after expansion	1.12	1.17	1.21
Volume percentage of air	20.0	16.5	13.5
Ccm air	20.4	15.8	12.4
Vitamin content I. U	2,300	2,580	2,580
Vitamin loss I. U	1,340	1,040	826
Vitamin loss in per cent	58	40	32

By experiments it has further been found, that the losses do not exceed the figures calculated above.

The specific gravities of the briquets obtained at the optimum content of dry substance can usually be increased by 3 to 6% by employing pressing periods of 30 seconds to 2 minutes or by subjecting the briquets to an after-pressing in matrices for 5 to 15 minutes at a surface pressure below 50 kg per sqcm.

Briquets having too low a content of dry substance are exposed to attacks by mould and at a content of dry substance essentially below the optimum content the product has a tendency for cracking in the side surfaces whereby the air obtains access to the interior of the briquets. This formation of cracks takes also place when the specific gravity of the briquets, irrespective of the cracks, is relatively high. A surface pressure of about 200 kg/sqcm corresponds as a rule to an optimum content of dry substance which is the lowest which can be used for obtaining a durable briquet.

The more the content of dry substance exceeds the optimum content of dry substance the higher pressing pressure has to be used for obtaining a briquet of equal specific gravity. It is, however, preferable to use comparatively low pressing pressures because the press in this case may be of lighter construction, and the time for rising the pressure may be shortened and consequently the effect of the press made greater. The consideration of these facts leads to the conclusion that for each material there is a definite relatively high content of dry substance which preferably should not be exceeded. In the above example it should be 86% if 1000 kg/sqcm should be considered as the highest surface pressure that is suitable for advantageous construction of presses. At contents of dry substance exceeding 90% very high pressures are required.

In briquetting green vegetables, such as spinage, one will find that a briquet pressed at the optimum content of dry substance is far darker than a briquet pressed under otherwise equal conditions from the same raw material but at a content of dry substance of about more than the optimum content of dry substance (for spinage about 90%) corresponding to 1000 kg/sqcm.

This darker colour depends evidently on the fact that the concentrated juice present in the dried plant tissue exudes therefrom and fills the air interspaces whereby the plant parts are stuck together to a briquet of high specific gravity which expands only little even if it is pressed at relatively low pressure.

This explains the above-mentioned limits for the contents of dry substance, inasmuch as the juice has to be condensed at least to such a concentration that its viscosity affords the required stickiness (that it thus does not flow freely) but on the other hand must not be condensed beyond the concentration at which the juice assumes a hard or even brittle consistency.

The higher the concentration of the juice is between these limits the higher is its viscosity and the higher pressure and the longer pressing period have to be employed in order to bring about the required dislocation of the condensed juice which agrees with the above-mentioned experience about the connection between content of dry substance and pressing pressure.

The spinage used for the above-mentioned briquetting experiments contained 7.2% dry substance and the juice squeezable from the fresh spinage still contained 3.6% dry substance after filtration. The dry substance of the juice amounted consequently to about 50% of the total dry substance and it can be said that the amount of the binding medium was about 100% of the solid mass to be briquetted.

The higher this percentage of binding medium is for solid masses of the same constant nature the lower pressure can be used at the briquetting process. This is clearly apparent for instance with white cabbage which has more than 70% binding medium in the autumn and can then easily be briquetted at 200 kg/sqcm while white cabbage stored in cellar over one winter has only 30 to 40% binding medium and therefore requires 500 kg/sqcm or more in order that an exudation of juice can take place and a briquet of high specific gravity be obtained.

On the other hand briquets having too high a content of binding medium become soft and flexible. This is for instance the case with fruits having high sugar content and relatively low content of solids.

Whether a certain material can be briquetted according to the present method depends however above all upon the nature of the solids. If thus the solids contain larger amounts of ducts and supporting tissues and the like or if the tissue is lignified this will cause the briquet to show a strong tendency to expand immediately upon pressing as well as after some hours or days.

The higher the percentage of such expanding constituents is the higher the percentage of binding medium has to be in order that the material shall be pressable to a briquet having high specific gravity. As an example it can be stated that carrots in their capacity of roots have a rather fibrous tissue but that this feature will be balanced by the rather great content of sugar of the juice so that in any case young carrots render compact briquets.

As is known the number and the coarseness of the fibres increase with the age of the plant. Young plants are therefore throughout easier to briquet according to the method described herein than older plants of the same species. Also the material to be briquetted should preferably be free from coarse ribs.

It is not advantageous to raise in the briquetting process the pressing pressure too rapidly since in such case it should be necessary to use longer pressing periods or essentially higher surface pressures for obtaining briquets of the desired specific gravity. It is, as a rule, not suitable to let the surface pressure rise faster than 100 kg/sqcm/sec.

This may, just as the already mentioned experiences over the connection between content of dry substance and surface pressure, be explained by the presence of a concentrated juice of high viscosity. Its diplacement must in fact take place more slowly at high pressure since the interspaces in which this juice shall flow are narrowed. Although much more strongly the same conditions prevail in the pressing of oil out of oleaginous seed.

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