Title: EXTRACTION OF B-VITAMINS FROM PLANT MATTER

Abstract: A process for the extraction of the B group of vitamins from a first plant matter is disclosed wherein, prior to the said extraction operation, the first plant matter is treated with a second plant matter comprising acidic compounds. The acidification converts the said vitamins into more water-soluble forms and increases the yield thereof. In one example, the first plant matter comprises guava fruit matter, holy basil leaves and lemon peels, the two last-mentioned plant species being the source of the acidic compounds. The vitamins extracted and the proportions thereof can be controlled by a suitable choice of the plant species constituting the first and second plant matters and their quantities such as to give a substantially ready formulation conforming to RDA values or other requirements. The vitamins extracted are B1, B2, B3, B5, B6 and B9, the above combination of plant matters giving higher yield than others. The process is of general applicability to other plant constituents.
Extraction of B-vitamins from plant matter

This invention relates to a process of extraction of the B group of vitamins and other nutrients from plant matter and more particularly to a process of extraction of the B group of vitamins and other nutrients from plant matter by using water as solvent, wherein a first plant matter to be extracted is treated with one or more acidic compounds such as to convert one or more of the said B vitamins into forms thereof that are more water-soluble, said treatment of the said first plant matter with acidic compounds being carried out either before or during the said extraction thereof by water.

The B group of vitamins comprises the following:

(i) Vitamin B1 - Thiamin
(ii) Vitamin B2 - Riboflavin
(iii) Vitamin B3 - Niacin
(iv) Vitamin B5 - Pantothenic acid
(v) Vitamin B6 - Pyridoxine
(vi) Vitamin B9 - Folic acid
(vii) Vitamin B12 - Cyanocobalamin

The B group of vitamins are water-soluble. However, their solubility in water is low and it varies considerably from one member of the group to another. Prior art processes of extraction of the B group of vitamins from plant matter employ water as the solvent. Because of the factors mentioned, the extraction of the B vitamins in prior art processes is low and is not uniform in view of the considerable differences in solubility between the members of the said group. The rate of extraction is also low. The process of the invention provides increased yield of said vitamins in the extract and increased rates of dissolution of the said vitamins in the extracting solvent. That is, in contrast to the prior art, the extraction process is faster in the process of the invention and the yield greater.

In the process of the invention, the solubilities of one or more of the B vitamins of the group are enhanced by conversion thereof into more water-soluble forms. Said conversion is carried out by treatment of the said first plant matter containing the B vitamins with one or more acidic
compounds. The acidification converts them into forms that are more readily soluble in water. Such forms are salts, esters, alcohols and others. The scope of the terms 'acidic compounds', 'acidic constituents' and 'acidic components' is intended herein to include both free acids and compounds that are not free acids but are acidic.

Attention is drawn to the co-pending application for patent No. 2677/CHE/2011 dated 4th Aug 2011 by the present applicants/inventors wherein a process for the extraction of plant matter is disclosed. In the said disclosed process, a first plant matter, that is the plant matter to be extracted, is treated with a second plant matter that comprises acidic constituents. Said first and second plant matters are brought into contact for the purposes of said treatment and accompanying reactions, either before or during the extraction thereof by water.

During said contact, the said acidic component(s) react with the vitamin and mineral components of the first plant matter converting one or more of the water-soluble vitamins and minerals therein into more water-soluble forms and/or one or more of the water-insoluble vitamins and minerals therein into water-soluble forms. Said water-soluble forms and more water-soluble forms comprise salts, esters and other compounds resulting from the reaction(s) of the said vitamins and mineral constituent(s) of the said first plant matter with the said acidic constituents contained in the said second plant matter.

For example, one or more of the fat-soluble but water-insoluble vitamins A, D, E and K are converted into water soluble forms in the process of the invention. Similarly, one or more of the other water-insoluble vitamin and mineral constituents therein are also converted into soluble forms. Said acidic treatment of the invention also converts some water-soluble nutrient(s) therein into forms that are more water-soluble.

The highlight of the process disclosed therein is that it is thereby able to extract substantially all the desired vitamins and minerals by means of a single solvent, namely, water. Another highlight is that in the process of the invention, this is done in a single extraction operation.

An extraction operation may, however, comprise a plurality of stages within the scope of the invention. The vitamins and minerals and other food and medicinal constituents of plants are referred to therein, and also herein, by the generalised term 'nutrients'. Said acidic treatment also enhances extractability and the yields are observed to be higher than in prior art procedures.
It may be noted that the scope of the process of the invention is applicable to any of the nutrients, that is plant constituents, and is not limited to B vitamins.

The process of the invention offers the option of selecting said acidic components such that all the desired vitamins and minerals are obtained in the extract through a single extraction step with a single extraction solvent. Other synergies and cost benefits such as better yields, shorter processing times and others, are also realised. Thus, within the scope of the invention said second plant matter may comprises a mixture of plant species selected such as to give a spread of said acidic components leading to higher yields and said synergies and cost benefits.

The disclosure in said co-pending application is incorporated herein by reference.

In this specification, an extraction may comprise a single extraction stage or a plurality thereof.

The objects of the invention and the advantages thereof are indicated at different points in the specification. Other objects and advantages will be apparent from the description and claims.

According to the invention, therefore, there is provided a process for the extraction of the B-vitamins from plant matter(s), as also optionally other nutrients and constituents thereof, comprising

(i) providing a first plant matter(s) containing one or more of the B-vitamins and other said nutrients desired to be extracted,

(ii) treating the said first plant matter(s) with one or more acidic compounds which may comprise free acids or otherwise, to render one or more of the said B-vitamin components and nutrients that are water-soluble into form(s) that are more water-soluble, and/or that are water-insoluble into form(s) that are water-soluble,

(iii) extracting the mixture of the said first plant matter(s) and the said one or more acidic compounds with water, or a dilute extract solution coming from a previous, or another, extraction,

said treatment and extraction steps being carried out simultaneously or otherwise.

Said acidic compounds may be any of the mineral acids such as hydrochloric, sulphuric, nitric, phosphoric or others. Preferably they are organic acids such as succinic, citric, tartaric, acetic,
ascorbic or others. Within the scope of the invention, said acidic compounds may comprise compounds other than free acids. The compound(s) used in said treatment may be mixtures of free acids and other acidic compounds within the scope of the invention.

More preferably the organic acids adopted for said treatment are in the form of one or more plant matter(s), that is, plant matter(s) that comprises inherent acidic compounds, such as for example, lemon peels containing citric and ascorbic acids, or amla fruit matter containing ascorbic acid, or others. Said inherent acidic compounds may be either free acids or otherwise, or combinations of the two. Said plant matter(s) containing the acidic compounds selected for the said treatment of the B vitamins and other nutrients is referred to herein as the second plant matters).

It will be observed that extraction of the nutrients from the said second plant matter will also take place simultaneously during the extraction of the B-vitamins contained in the said first plant matter, in the process of the invention. Said nutrients of the second plant matter(s) may also undergo reaction with the said acidic components therein to a greater or lesser extent.

Thus, within the scope of the invention, the roles of said first and second plant matters are not mutually exclusive. The B vitamins, as also any of the other vitamins, minerals or other plant constituents that are desired to be extracted may come from said first plant matter(s) or from said second or from both. Similarly, the acidic matter involved in said treatment may come from acidic constituents present in the said second plant matter(s) or partly from said first and partly from said second plant matters.

Both said first and second plant matters may comprise a single plant species or a plurality thereof within the scope of the invention. The terms 'first plant matter(s)' and 'second plant matter(s)' have been used in the claims and description to convey the said scope. The forms 'first plant matter' and 'second plant matter' have been used at some places for convenience but it may be noted that the same scope is intended. This scope is intended wherever the term 'plant matter' appears herein.

Where said first plant matter and/or said second plant matter comprises a plurality of plant species, it will be observed that different combinations as regards said contacting and treatment are possible. Different combinations offer different sets of benefits and advantages from the point of view processing parameters and costs, such as, for example, yields, processing times and others.
The B vitamins and other said nutrients contained in the said second plant matter(s) undergo the same treatment as those in the said first plant matter(s). Similarly, the said acidic matters present in both said first and second plant matters take part in said treatment of the B vitamins and nutrients present in both said plant matters.

The invention offers a wide scope for selecting said first and second plant matters such that the desired B vitamins, and other plant nutrients as applicable are extracted in the most optimum manner. That is, the invention offers several cost benefits such as, for example, increased yield, decreased processing times, reduced handling of materials, better capacity utilisation and reduced operational and capital costs through the appropriate selection of the said first and second plant matters and the nutrients and acidic components therein.

The invention also offers the option of selecting the abovementioned parameters, that is, the nature and proportions of the said first plant matter(s) and said second plant matter(s) and the said acidic constituents thereof such as to yield a nutrient mixture, for example, a mixture of the B vitamins wherein the proportions of the said nutrients are substantially as that required for administration to subjects for particular treatments, symptoms or nutritional requirements.

Such proportions may be such as those laid down as RDA (Recommended Daily Allowance) values or other authorities as required by health, medical or other considerations. It will be seen that obtaining the vitamin mixture (or other nutrient mixture) in desired therapeutic or nutritional proportions right at the conclusion of the extraction step eliminates considerable amount of processing that is otherwise required in prior art processes. In prior art processes, the vitamins, minerals and other said nutrients are first produced in isolated condition only to be subsequently compounded to give the desired mixtures.

A variety of organic acids are available in plant matters. Within the scope of the invention said first and second plant matters may be a mixture of plant matters of different species. This provides the option of selecting a combination of vitamin B and other nutrient sources and of said acidic compounds, such as to optimise the extraction in terms of the yields, the range of the nutrients extracted, the duration, rate and other parameters of extraction, the distribution and proportions of the B-vitamins and other said nutrients in the extract. The species constituting said first plant matter are selected such as to get the desired said nutrients in the extract in an
optimum manner. The invention offers considerable latitude in the selection of the species that go into said first and second plant matters.

As mentioned hereinabove, the roles of said first and second plant matters are not mutually exclusive and they may play dual roles. Where the said plant matters are in dual roles the abovementioned selection considerations may be applied in respect of each of the plant species being considered whether forming part of said first, or said second plant matters.

Within the scope of the invention a said first plant matter may additionally play the role of said second plant matter and vice versa. Both said first and second plant matters may be in such dual roles within the scope of the invention.

Within the scope of the invention, options exist as regards the plant part to be taken up for extraction. Thus, each of the plant species selected as said first and/or second plant matters in the process of the invention may comprise any of the plant parts thereof, such as, leaves, bark, fruits, flowers, seeds, branches, roots, rhizomes or others, or mixtures thereof. The choice will depend on their nutrient constituents and the forms in which they are present, the said acidic constituents, the extractability of the said forms, the convertibility of said forms, cost considerations and others.

By selection of the appropriate source of the B vitamins, namely, the specie(s) constituting said first plant matter and the appropriate organic acid(s) and other acidic compounds in the species constituting said second plant matter for the treatment of said first, it is possible to enhance the solubilities, and therefore the extraction of the B vitamins while at the same time minimising the conversion of the non-vitamin B components that are not water-soluble into water-soluble forms.

In this way, increase in the extraction of the B vitamins is achieved in the process of the invention and the processing times reduced.

Within the scope of the invention, the role played by said first and second plant matters may be dual that is both can be the source for the desired B vitamins and other nutrients and also the source of the said organic acidic reacting compounds.
Thus, it is possible to select said first and second plant matters such as to generate synergies, cost benefits and other advantages. One such synergy is mentioned hereinabove is the enhancing of the extraction of the B vitamins while suppressing the extraction of the other vitamin and mineral components that are not desired.

Within the scope of the invention, said first and second plant matter(s) may be dried and reduced in size for better contact when intermixed. Powdering the two plant matters is also an option. Alternatively, they may be converted into pulps and intermixed. A medium such as water may be used for enhancing the contact between the two plant matters. Thus, the two plant matters may be wetted with water or dispersed/slurried in water. Fluidisation and other means of contacting are also within the scope of the invention. Heating and pressure application to accelerate the said treatment is within the scope of the invention.

AS mentioned, the process of the invention offers a range of options as regards contacting the various species constituting said first and second plant matters carrying out the said treatment. Said species for said contacting and treatment may be taken up singly or collectively in groups. Such flexibility can be explored to generate processing advantages and cost benefits.

Thus, the process of the invention offers mixtures that are ready for administration to subjects without the necessity of compounding operations such as admixing, homogenising, blending, sifting and the like. Such operations are optional finishing operations for the product. An administrable product in solution form is obtained at the conclusion of the extraction step and in solid form by the simple step of evaporation of the solvent from the said solution. Compounding the product with one or more suitable excipients, binders and other additives to get a solid form extract product is within the scope of the invention. Agglomeration operations such as tabletting, pelletising and others on the solid form extract may be adopted if desired. Within the scope of the invention, the process of the invention may include a topping-up step to make the adjustments necessary to bring the mixture product of the invention in correspondence with the set of RDA figures or other such standards/specifications.

Thus, it is possible to obtain by the process of the invention, an extract product that is substantially a specific combination of said B vitamins (and/or other said nutrients) and having the desired proportions thereof. Such tailor-made extract compositions/products reduce the cost of further processing thereof towards the making of formulations. They also make said further
processing simpler and offer savings in energy, material and other costs. The selected proportions may be the RDA values or others.

The terms 'extract product' and 'extract' are used herein to refer to a solution of said nutrients in the solvent, namely water. The terms apply to extract solutions at any stage in the overall extraction process for extracting the B-vitamins and other nutrients from plant matter and also refers to the said solution obtained at the completion of the said extraction process. Said terms are also used to refer to the product after any subsequent treatment of the extract, such as for example, after solvent removal and after any downstream operations such as drying, crystallising, crushing, grinding, homogenising, pelletising, agglomerating and others. The water solvent is removed from said final solution at the completion of the said extraction process. Said removal yields the extracted nutrients in a concentrated solution form or as a solid or semi-solid residue. Said terms are also used to refer to said concentrated solution and the solid and semi-solid residues. The meaning appropriate to the context may be taken.

Any of the known drying processes may be adopted as required. In the embodiment described in detail hereinbelow, the concentrated solution containing the B vitamins is filtered and then subjected to a spray drying operation to yield the solid extract product. The adsorbed extract product is powdered and homogenised. Any other optional process operations such as filtration, size reduction, mixing, homogenising or others may be carried out as required within the scope of the invention.

The term 'extracted plant matter' is intended to refer to 'spent plant matter' resulting at any stage of the extraction process including at the completion of the process. The terms 'extracted plant matter', 'spent plant matter', 'spent matter' and 'residual plant matter' are used interchangeably. The term water solvent is intended for the purposes of this description and claims to cover within its scope not only pure(fresh) water but also dilute solutions of the said B vitamins and other nutrients in water. Thus, references in the claims to extraction of the plant matter by water also includes extraction by water containing said B vitamins and other nutrients in solution. Such extract streams arise in multi-stage extractions. In such multi-stage extractions, material streams such the dilute and rich extracts, spent matter and the fresh solvent can be organised in different patterns such as is known in the art. Different patterns offer different advantages and cost benefits in capital and operating costs.
The extraction thus results in a substantially ready-made B-vitamin composition that is a very
convenient intermediate for processing into different dosage forms. Where adjustments are
necessary in the component levels, topping by previously isolated B vitamin components may be
carried out as part of the process of the invention.

It will be observed that the process provides considerable processing advantages and techno-
economic benefits. In the prior art systems the nutrient components are extracted and isolated.
Thereafter, the isolated nutrient components are admixed again to form the desired combination
of the nutrients such as, for example, a formulation comprising a set of the B vitamins. The
process of the invention makes redundant several operational steps and plant equipment required
in the prior art procedures.

Thus, in one of the embodiments of the process of the invention for the extraction of the B group,
said first plant matter comprises guava fruits, Holy basil leaves and lemon peels. The nutrients
that are of interest therein and that are extracted by the process of the invention in said three
components of the first and second plant matter mixtures are: B1 B2, B3, B5, B6, and B9
vitamins.

The said second plant matter in this embodiment is also a mixture of different species. It
comprises Holy basil leaves and lemon peels. The former contains several acid components
such as oleanolic acid, ursolic acid, rosmarinic acid while the latter contains citric and ascorbic
acids. As mentioned, said plant matters may constitute both said first and second plant matters
simultaneously within the scope of the invention. Within the scope of the invention, a said plant
matter may constitute the nutrient(s) source or the source of said acidic compounds or both.

Within the scope of the invention, the operation of extraction may comprise a single stage or
multiple stages. Many arrangements are possible as regards the number of stages, nature of
extraction, routing and handling of the different extract and spent matter streams and the use
thereof as product and/or as an extracting solvent, method of contacting of the solvent and
material to be extracted, and with regard to other process factors. Solvent removal may be
adopted at any stage in the extraction or at the completion of extraction. Said solvent removal
may be in one or more stages. Some of the said extract streams may be used as solvents for
extraction of fresh, or partly spent plant matter(s). All such possible variants of the process of
the invention are within the scope thereof.
A number of known methods of carrying out the extraction step or the solvent removal step and other steps are known in the art. The process of the invention may adopt any of those or combinations thereof within the scope of the invention.

Within the scope of the invention, the administrable extract obtained by the process of the invention which is a very suitable intermediate, may be converted into any of the known dosage forms and/or into any of the known pharmaceutical salts. Within the scope of the invention, the nutrients in the said administrable extract may be carried on any suitable pharmaceutically accepted carrier.

Within the scope of the invention, other operations may be carried on the extract product of the invention such as topping-up of constituents, adding of additional nutrients, converting into a food, pharmaceutical or nutraceutical compositions, admixing additives such as for colour, taste, texture, bulk, flavour, odour and others.

In order to provide a clearer understanding of the invention, and without limitation to the scope thereof, an embodiment thereof is described in detail hereinbelow.

The three plant matter components, guava fruits, holy basil leaves and lemon peels were taken in the proportions of about 198:1:1 by wt.
Guava fruits were taken and they were cleaned and washed in running water. Thereafter the fruits were chopped in an SS chopper machine. The guava fruits were not dried as drying tends to decompose the vitamin components in the fruit.

About 495 kg. of the chopped(pulped) fruit was taken.
The holy basil leaves were taken and dried in open air under a shade. The dried material was ground in a swing hammer mill.
About 2.5 kg. of the dried leaf powder was taken.
The lemon peels were taken and also dried in the open air under a shade. The dried material was ground in a swing hammer mill.

About 2.5 kgs. of the dried lemon peel powder was taken.
The three materials were charged into an extractor which comprised an SS vessel of about 5000 L capacity provided with an agitator system and a steam jacket for heating the contents.
About 2000 L of water were charged into the extractor. The extractor was maintained at about 50 to about 65 C by heating with steam. The extraction was carried out for about 6 hours during which period circulation of the solvent/extract was maintained. The extract was withdrawn from the bottom of the extractor and pumped to the top of the bed of plant material.

At the end of the extraction period the extract was drained from the extractor. About 1500 L of extract was obtained. This is referred to herein as the first extract batch.

The plant material bed was again extracted by charging about 2000 L of water the other parameters being as in the first extraction. A batch of about 1500 L of extract was obtained from this extraction stage. This is referred to as the second extract batch.

The twice-extracted plant matter was subjected to a third stage of extraction. Again about 2000 L of water were charged. All other parameters were as in the first and second stage extractions. A batch of about 1500 L of extract was obtained. This is referred to as the third extract batch.

The said first and second batch extracts were individually concentrated at about 50 to about 65 deg. C down to a volume of about 150 L each. The two batches of concentrated extract were combined. This was the solution extract product of the invention.

The product extract was filtered in an SS Nutsche type filter using Hyflosupercl as filter aid.

The clear filtrate was subjected to spray drying in a SS spray drier at about 170 to 180 deg. C to give the extract product in the solid form.

The spray dried product was powdered in a SS multi-mill and sifted in a SS sifter to a particle size of about 40 to 80 mesh. The sifted material was blended in an octagonal blender for about one hour. About 40 to 50 kg. of dried powdered product was obtained.

The homogeneous powder product can be further processed by known processes to give formulations in the desired dosage forms.
The residual plant matter in the extractor after being subjected to three extractions was taken out and discarded.

The third batch extract was used to extract a batch of fresh plant matter.

The dried powdered product was analysed and the analysis is given hereinbelow.

It will be observed that in this embodiment, the said treatment and extraction operations are carried out simultaneously in water medium. The said first and second plant matters, after suitable preparation are charged into an extractor vessel to which the water solvent is charged. The two plant matters are slurried in the water solvent by suitable agitation. The said treatment reactions occur in the slurry medium. The extraction by dissolution of the said B-vitamins and other nutrients, in their original forms and in their converted forms into the water medium takes place substantially simultaneously with the said treatment reactions.

As mentioned, guava fruits, holy basil leaves and lemon peels constitute said first plant matters in this example while the said second plant matter comprises two components, holy basil leaves and lemon peels. The said B vitamins present in guava fruits are B1, B2, B5, and B6; in holy basil leaves B3, and in lemon peels B9. The acidic compounds in holy basil leaves are oleanolic, ursolic and rosmarinic acids. The acidic constituents of lemon peels are citric and ascorbic acids.

Table I gives a comparison of the extract of the abovementioned embodiment of the invention with the required values and parameters. Column 2 of the table gives the desired specifications and Column 3 gives the values obtained in the said extract of the embodiment. The quantities of the B-vitamins therein are in accordance with RDA requirements. The table indicates excellent correspondence of the said extract of the embodiment with the desired parameters, said correspondence being obtained in less processing time and with less processing steps than in the prior art processes.
Table I - Comparison of the extract of the embodiment of the invention with the required specifications.

<table>
<thead>
<tr>
<th>Physical Analysis</th>
<th>Specification</th>
<th>Actual Values</th>
<th>Testing method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance and Color</td>
<td>Greyish Brown to Brown powder</td>
<td>Complies</td>
<td>Visual</td>
</tr>
<tr>
<td>Identification</td>
<td>Positive</td>
<td>Complies</td>
<td>HPTLC</td>
</tr>
<tr>
<td>Taste</td>
<td>Bitter &amp; irony</td>
<td>Complies</td>
<td>Organoleptic</td>
</tr>
<tr>
<td>Odor</td>
<td>Characteristic</td>
<td>Complies</td>
<td>Organoleptic</td>
</tr>
<tr>
<td>Solubility</td>
<td>Soluble in water</td>
<td>Complies</td>
<td>USP XXIII</td>
</tr>
<tr>
<td>Loss on Drying</td>
<td>NMT 6% w/w</td>
<td>3.3%</td>
<td>USP XXIII (IR)</td>
</tr>
<tr>
<td>Particle size</td>
<td>98 % min. thro’ 20 mesh</td>
<td>100%</td>
<td>USP XXIII</td>
</tr>
<tr>
<td><strong>Assay of Actives</strong></td>
<td><strong>Specification</strong></td>
<td><strong>Result</strong></td>
<td><strong>Test Method</strong></td>
</tr>
<tr>
<td>Vitamin B1 (Thiamin)</td>
<td>NLT 22 mg/g (2.2%)</td>
<td>24 mg/g</td>
<td>HPLC</td>
</tr>
<tr>
<td>Vitamin B2 (Riboflavin)</td>
<td>NLT 20 mg/g (2%)</td>
<td>22 mg/g</td>
<td>HPLC</td>
</tr>
<tr>
<td>Vitamin B3 (Niacin)</td>
<td>NLT 34 mg/g (3.4%)</td>
<td>36 mg/g</td>
<td>HPLC</td>
</tr>
<tr>
<td>Vitamin B5 (Pantothenic acid)</td>
<td>NLT 38 mg/g (3.8%)</td>
<td>40 mg/g</td>
<td>HPLC</td>
</tr>
<tr>
<td>Vitamin B6 (Pyridoxine)</td>
<td>NLT 22 mg/g (2.2%)</td>
<td>24 mg/g</td>
<td>HPLC</td>
</tr>
<tr>
<td>Vitamin B9 (Folic acid)</td>
<td>NLT 700 mcg/g (0.07%)</td>
<td>755 mcg/g</td>
<td>HPLC</td>
</tr>
<tr>
<td><strong>Microbiology</strong></td>
<td><strong>Specification</strong></td>
<td><strong>Result</strong></td>
<td><strong>Test Method</strong></td>
</tr>
<tr>
<td>Total Plate Count</td>
<td>1000 cfu/gram max</td>
<td>Complies</td>
<td>USP XXIII</td>
</tr>
<tr>
<td>Yeast and Mold</td>
<td>100 cfu/g max</td>
<td>Complies</td>
<td>USP XXIII</td>
</tr>
<tr>
<td>Coliforms</td>
<td>Absent</td>
<td>Absent</td>
<td>USP XXIII</td>
</tr>
<tr>
<td>Salmonella</td>
<td>Absent</td>
<td>Absent</td>
<td>USP XXIII</td>
</tr>
<tr>
<td>E.coli</td>
<td>Absent</td>
<td>Absent</td>
<td>USP XXIII</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>Absent</td>
<td>Absent</td>
<td>USP XXIII</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>Absent</td>
<td>Absent</td>
<td>USP XXIII</td>
</tr>
<tr>
<td><strong>Chemical Impurities</strong></td>
<td><strong>Specification</strong></td>
<td><strong>Result</strong></td>
<td><strong>Test Method</strong></td>
</tr>
<tr>
<td>Heavy Metals</td>
<td>NMT 10 ppm</td>
<td>Complies</td>
<td>USP XXIII</td>
</tr>
<tr>
<td>Arsenic as As</td>
<td>NMT 0.5 ppm</td>
<td>Less than 0.001 PPM</td>
<td>USP XXIII</td>
</tr>
<tr>
<td>Mercury as Hg</td>
<td>NMT 1 ppm</td>
<td>Less than 0.01PPM</td>
<td>USP XXIII</td>
</tr>
<tr>
<td>Cadmium as Cd</td>
<td>NMT 1 ppm</td>
<td>Less than 0.01PPM</td>
<td>USP XXIII</td>
</tr>
<tr>
<td>Lead as Pb</td>
<td>NMT 1 ppm</td>
<td>Less than 0.01PPM</td>
<td>USP XXIII</td>
</tr>
<tr>
<td>Pesticides residue</td>
<td>Absent</td>
<td>Absent</td>
<td>USP XXIII</td>
</tr>
<tr>
<td><strong>Remarks</strong></td>
<td>The extract complies with the required specifications</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The process of the invention is simply and easily adapted for batch, continuous or semi-continuous operation.

Embodiments and variations other than described hereinabove are feasible by persons skilled in the art and the same are within the scope and spirit of this invention.
Claims:

1. A process for the extraction of the B-vitamins from plant matter(s), as also optionally other nutrients and constituents thereof, comprising

   (i) providing a first plant matter(s) containing one or more of the B-vitamins and other said nutrients desired to be extracted,

   (ii) treating the said first plant matter(s) with one or more acidic compounds which may comprise free acids or otherwise, to render one or more of the said B-vitamin components and nutrients that are water-soluble into form(s) that are more water-soluble, and/or that are water-insoluble into form(s) that are water-soluble,

   (iii) extracting the mixture of the said first plant matter(s) and the said one or more acidic compounds with water, or a dilute extract solution coming from a previous, or another stage of extraction,

said treatment and extraction steps being carried out simultaneously or otherwise.

2. The process for the extraction of the B-vitamins and other nutrients from plant matter(s) as claimed in the preceding claim 1 wherein said first plant matter(s) is treated with a second plant matter(s), the latter comprising the said one or more acidic compound(s) for the treatment of the former.

3. The process for the extraction of the B-vitamins and other nutrients from plant matter(s) as claimed in the preceding claim 2 wherein said second plant matter(s) also comprises one or more of the said B group of vitamins and nutrients and performs a dual role in the said process of being a source of said acidic compound(s) and, as well as, of the one or
more of the said B group of vitamins and nutrients.

4. The process for the extraction of the B-vitamins and other nutrients from plant matter(s) as claimed in any of the preceding claims 1 to 3 wherein said first plant matter(s) also comprises one or more said acidic component(s) and performs a said dual role in the said process of being a source of said one or more of the said B group of vitamins and, as well as, of the said one or more acidic compound(s).

5. The process for the extraction of the B-vitamins and other nutrients from plant matter(s) as claimed in any of the preceding claims 1 to 4 wherein said treatment and the said extraction-by-water steps are carried out substantially simultaneously by dispersing(slurrying) the said first and second plant matters in the water solvent.

6. The process for the extraction of the B-vitamins and other nutrients from plant matter(s) as claimed in the preceding claims 5 wherein the said first plant matter comprises guava fruits, holy basil leaves and lemon peels and the said second plant matter comprises lemon peels and holy basil leaves, the holy basil leaves and lemon peels being in the said dual role of being a source for both the said B vitamins and other nutrients and the said acidic compounds.

7. The process for the extraction of the B-vitamins and other nutrients from plant matter(s) as claimed in the preceding claim 6 and comprising multiple stages of extraction wherein the extracting solvent comprises either water or a weak extract solution coming from another said stage, or mixtures thereof.
8. The process for the extraction of the B-vitamins and other nutrients from plant matter(s) as claimed in any of the preceding claims 1 to 7 wherein the said treatment operation is carried out by pulping the said first and second plant matters and contacting the said two plant matters in powder/pulp form for a length of time followed by contacting thereof with the water solvent.

9. The process for the extraction of the B-vitamins and other nutrients from plant matter(s) as claimed in any of the preceding claims 1 to 8 wherein the said first and second plant matter(s) are optionally subjected to one or more of preparatory operations such as, for example, washing, cleaning, dicing, cutting, drying, crushing, grinding, milling, screening, blanching and others.

10. The process for the extraction of the B-vitamins and other nutrients from plant matter(s) as claimed in any of the preceding claims 1 to 9 and optionally and additionally comprising one or more of the undermentioned steps:

(i) removal of the solvent from the extract solution by any of the known procedures such as, for example, evaporation to yield a concentrated extract product;

(ii) removal of the solvent from the extract solution by any of the known procedures such as, for example, evaporation to yield a solid, or semi-solid extract product;

(iii) drying of the product from (i) or (ii) by any of the known drying procedures to yield a solid form extract product and optionally subjecting the said product to any of the known finishing or other operations such as powdering, sieving, sifting, mixing, homogenising and others;

(iv) producing a solid form extract by adsorbing the extract on a suitable excipient and adopting a suitable binder as required;

(v) converting the extract into any of the known dosage forms;
(vi) converting the B group of vitamins and other nutrients in the extract into any of the known pharmaceutically acceptable salts;

(vii) adopting any of the known pharmaceutical carriers for the B vitamins and other nutrients of the extract;

(viii) incorporation of additives such as for colour, texture, taste, flavour, bulk, odour and others in the said extract;

(ix) topping-up of one or more of said B vitamins and other nutrients and/or addition of one or more of other said B vitamins or nutrients such as to bring the extract into correspondence with any desired standard or specification, or for other purposes; and

(x) any of the known processes/procedures for enhancing the efficacy or assimilability of one or more said B vitamins and other nutrients in the extract.

11. A process for the extraction of the B-vitamins and other nutrients from plant matter(s) substantially as hereindescribed.

12. An extract product produced by a process as claimed in any of the preceding claims 1 to 11.