Title: NOVEL POLYPHENOLIC POLYMERIC COMPOSITIONS, METHOD OF THEIR ISOLATION, AND A METHOD OF ALTERING AND IMPROVING TASTE CHARACTERISTICS OF EDIBLE CONSUMABLES

Abstract: The invention deals with a method of altering, modifying thereby improving the sensory qualities of edible consumables such as taste, flavor or mouthfeel by adding thereto an effective amount of a polymeric polyphenolic material. Edible consumables include dairy products, alcoholic beverages, non-alcoholic beverages fruit-based products, condiments, brown foods, salty foods, and brothy foods. The polymeric materials of the invention are obtained from their natural sources by first processing the plant material, such as grape seeds or oak, with aqueous solvents to yield a crude extract which, upon further separation and processing, yields polymeric polyphenolic materials such as polyproanthocyanidins.
BACKGROUND OF THE INVENTION

Materials which add to or change taste or flavor of edible consumable such as spices, herbs and extracts thereof have been utilized for centuries. By "edible consumables" is meant any food or drink, or any ingredient that may be contained in any food or drink, that is intended for human consumption. Therefore "edible consumables" include, for examples, all types and varieties of prepared foods such as various dairy products, including especially low-fat or fat-free dairy products, or foods prepared from dairy products or that use dairy products as ingredients; soups or sauces; dressings mayonnaise and spreads including those that are low-fat and fat-free; all varieties of beverages, such as coffee, tea, chocolate drinks, juices, juice drinks, carbonated beverages, alcoholic beverages including wines, coolers, beer, liqueurs, brandies and whiskies; various desserts that may contain one or more of the following ingredients: dairy products, fresh fruits or artificial fruit flavors; and any other foods or beverages. Included among such materials are a few which also modify the taste or flavor elements present in food (referred to hereinafter as flavor modifiers). The goal and purpose of employing such materials is to "---impart a flavor of choice, to modify a flavor that is already present or to mask some undesirable

Further benefit of employing flavor modifiers is that they may enable one to minimize the use of such ingredients as fats, lipids, salt, etc. without the loss of their positive flavor attributes and acceptability. It is even more desirable when the flavor modifiers can not only improve the taste or related sensory values of edible consumables, but also provide positive health benefits.

The earliest and most extensively used of food modifiers are spices and herbs. Other well known flavor enhancers are monosodium glutamate (MSG) and the 5'-ribonucleotides, maltol, ethyl maltol, and hydrolyzed vegetable proteins. It is important for the purposes of this invention to note that generally such flavor modifiers, whether naturally or synthetically produced, have identifiable flavor characteristics of their own, and have an effect on taste when introduced to foods at concentration levels that are at or above the concentrations where their own flavor characteristics are detectable.

For example U.S. Patent 5,077,062 describes the use of soy hydrolyzates as flavor enhancers. In the March 1999 issue of *Prepared FOODS*, p.79, it has been disclosed that the same flavor enhancer (trade named
"Soyarome") is based on fermented soy flour. More recently, U.S. Patent 4,906,480 discloses the use of monomeric polyphenols, particularly flavonoid compounds such as monomeric proanthocyanidin compounds, to enhance (increase the magnitude) and to extend sweetness by extending the length of time sweetness is perceived when said compounds are combined with sweeteners in a chewing gum. By the term "polyphenol" used hereinafter is meant a molecule that contains multiple phenolic groups.

U.S. Patent 5,631,038 discloses the use of a variety of compounds referred to as "tastands" which blocks, reduces eliminates undesirable taste(s) such as sweet, bitter, sour etc. The disclosed compounds include a great variety of diverse chemical classes, including some monomeric phenolic materials.

The materials employed in the present invention differ in two critical aspects from the specific monomeric material disclosed in said patent: 1) they act as complex and unique flavor modifiers (increasing some tastes, decreasing others, and changing the location on the tongue of taste perception of still others); and 2) they are polymers containing more than seven polyphenolic repeat units.

The extraction and isolation of phenolic monomers and oligomers has been described in the technical literature and also in a number of patents, including
British patent 1,541,469; French patents 968,589; 1,036,922; 1,427,100 and U.S. patents 3,436,407, 4,698,360 and 5,912,363. These disclosures clearly stated, however, that the isolated materials are monomeric or oligomeric proanthocyanidins, containing at most seven repeat flavan-3-ol units. Polymeric polyphenolic materials have not been isolated using prior art methods. Such polymers have not been characterized either from a sensory or a physical standpoint. At least in some referred to patents a special effort is made (for example in U.S. patent 5,484,594) to exclude the higher polymeric materials which may be present and which are said to be basically water insoluble and hence not useful.

U.S. patent describes the use of oak chips to flavor or age wine, but first the oak chips are soaked in water or aqueous ethanol to remove the undesirable flavors. Then after toasting the oak chips they are used to age or flavor wine. The soaking in aqueous ethanol clearly removes at least some of the polymeric polyphenols that makes up the composition of the present invention.

As indicated above, the prior art discloses that the monomeric and some oligomeric proanthocyanidins extend the length of time that sweetness is perceived in an artificially sweetened chewing gum. The prior art, however, does not disclose, teach or suggest that
polymeric polyphenols, such as proanthocyanidins or other phenolic based polymers, modify, improve, enhance, blend or otherwise alter and control the tastes, flavors, and even aromas of certain complex foods, ingredient mixes, beverages, drinks or other consumables.

**SUMMARY OF THE INVENTION**

This invention in general is directed to a method of modifying or altering, and/or enhancing and usually improving the flavor, taste, mouthfeel and/or other sensory qualities of "edible consumables" by incorporating therein an effective amount of a polymeric polyphenolic material (polymeric polyphenol material), which includes polymeric proanthocyanidins (PPCs) and other phenolic based polymers derived from plant matter. Said taste and flavor modification is actually accomplished with the higher molecular weight extract of plant material, especially from grape seeds. By higher molecular weight is meant the extract that generally has a molecular weight of at least 3,000 and more generally at least 5,000. In many instances this improvement or enhancement may be accomplished at levels of polymeric polyphenols below the detection threshold of its own sensory characteristics. As defined above, by "edible consumables" is meant any food or beverage, or any
ingredient that may be incorporated in any food or beverage, that is intended for human consumption.

One feature of the invention is the modification of taste or flavor of edible consumables by incorporating therein an effective amount of polymeric polyphenols. Such edible consumables include dairy products, alcoholic beverages, non-alcoholic beverages, fruit-based products, condiments, brown foods, salty foods, and brothy foods.

More specifically, a feature of this invention is directed to improving the flavor, taste and sensory properties of low-fat foods, low-calorie foods, artificial sugar replacements and low alcohol beverages to impart sensory values normally associated with the full fat and full alcohol equivalents of such foods and beverages using the inventive materials as taste, flavor, mouthfeel, and/or sensory modifiers.

Another aspect of this invention is the ability to add astringency to a food or beverage without adding bitter taste or any other undesirable characteristic.

Yet another aspect of the invention is a method of altering and thereby improving the intrinsic astringency/bitterness ratio of a food or beverage (including wine) by the addition of a polymeric polyphenolic material of this invention when a PPC or any other polymeric polyphenol material is
incorporated into a food product, a beverage, or a
food additive at concentration levels above those at
which their intrinsic properties are manifested, which
is generally above 500 ppm based on the weight of food
or beverage.

Another aspect of the invention is an edible
consumable containing an effective amount of a
polymeric polyphenolic material, especially where such
material has been extracted from a plant material.

Still another feature of the invention is a
method of extracting and isolating polymeric
polyphenols, especially polyproanthocyanidins, from
plant matter, which method comprises extracting the
plant material with water or a mixture of water and an
organic solvent such as acetone or ethanol;
concentrating the extract; redissolving the extract in
ethanol; and precipitating or otherwise separating in
concentrated form the polymeric polyphenol portion.

Yet another aspect of the invention is the novel
and unique polymeric polyphenolic compositions that
result from the extraction from plant matter and the
novel isolation and purification methods of this
invention.

In addition to the taste modification, a further
feature of the invention is a method of providing
health properties to the foods and beverages by the
addition of the above described effective amount of a
polymeric polyphenol material to a particular food or beverage and the compositions derived therefrom. This effect is achieved because the polymeric polyphenol materials are particularly effective radical scavengers and therefore, they prevent and repair the harmful biological effects caused by free radicals. Furthermore, polymeric polyphenol materials inhibit platelet aggregation which is a major contributing factor to a variety of cardiovascular diseases and have recently been shown to reduce the toxic side effects on liver, kidney, lungs and other organs of numerous efficacious but potentially toxic therapeutics. Thus the foods and beverages containing a polymeric polyphenol material composition of the invention possess antitumor, anticholesteremic and other disease resisting properties in addition to having an improved flavor. For particular effectiveness as a therapeutic agent it may be necessary to ingest by an average person 50 mg. to 250 mg. of a polymeric polyphenolic material such as a PPC, in other words a grape seed extract, an oak extract or other plant extract containing at least 40% by weight of a polymeric material, preferably at least 50% of polymeric material and even at least 60%, 80% or up to 90% and 95.5%. The dosage of the composition of the invention may be absent 1 to 5 mg. per kilogram
of body weight per day, depending on the purity of the extract.

The polymeric materials of the invention are obtained from their natural sources by first processing the plant source material with aqueous solvents, including those containing miscible organic co-solvents (such as, but not limited to, acetone and ethanol). This treatment yields a crude extract which, upon further separation and processing, yields the desired polymeric polyphenol materials. The further isolation and purification may be achieved using a sequence of dissolution and precipitation or other isolation methods and drying methods known in the art.

The further use of certain adsorbent materials provides unexpected and useful fractions of relatively pure polymeric materials present in the crude extract.

DETAILED DESCRIPTION OF THE INVENTION

The present invention deals with a method of altering, modifying and generally improving the sensory qualities of edible consumables, said method comprising adding to an edible consumable an effective amount of a polymeric polyphenol material (polymeric polyphenol material). The sensory qualities that are altered, modified and generally improved are the taste, flavor or mouthfeel of a variety of prepared foods and beverages.

The proanthocyanidin-based polymeric materials employed in the present invention belong to a broad
class of compounds known generically as condensed tannins with a fundamental chemical structural unit known as a flavan-3-ol. These polymeric materials most conveniently may be obtained from many plants. Such materials are also known as condensed tannins, non-hydrolyzable tannins and more specifically are leucoanthocyanins, anthocyanidins, procyanidins, cyanidins, catechins which include epicatechin, gallatechin, epigallocatechin, prodelphins, hydroxyflavan-3,3-diols and others of similar nature. These polymeric phenols are believed to be based on three basic classes of phenolic constituents: (i) leucoanthocyanins (also known as proanthocyanidins), (ii) flavanol glycosides and (iii) esters, glycosides and amides of various hydroxycinnamic acids. Proceeding through complex biosynthetic processes, the plants synthesize a variety of phenolic compounds, including many polymers. An extensive and authoritative detailed discussion of this class of compounds may be found in "Practical Polyphenolics" by E. Haslam, Cambridge University Press, 1998.

The most important polymeric polyphenols pertaining to this invention are polyproanthocyanidins (PPCs), but other polymeric polyphenols, such as those which may be obtained from oak and various processed and heated cellulosic sources, are also important and result in useful compositions manifesting many aspects of the invention. These polymers occur naturally in certain plants, together with the monomeric compounds and oligomers from which they arise.
The polymeric polyphenols, extracted and isolated from various plants, is a complex mixture of proanthocyanidin polymers and other phenolic based polymers that contain seven or more flavan-3-ol repeat units, and preferably ten or more repeat units, but may contain more than 20, more than 30, more than 50 and possibly even hundreds of repeat units. Although the extraction and isolation process described in greater detail below is designed to yield only the higher molecular weight fraction of such polymers, it must be understood that since the resulting material is a complex natural product it is possible that the isolated material may contain small amounts of monomeric and/or oligomeric proanthocyanidins or other phenolics. The presence of small amounts of such generally undesirable low molecular weight materials will not detract from the uniqueness of these compositions that contain primarily the higher polymeric components. The unusual properties of such compositions are derived from the higher polymeric adducts, especially those derived from proanthocyanidins (PCs). However, they have not been analytically or chemically characterized in detail and their sensory properties have not been identified in detail. All such polymeric polyphenolic materials are included in this invention as are other related polymers and the aggregates of such materials resulting from physical combinations, hydrogen bonding or other non covalent bonding interactions which may exhibit the flavor modifying properties of the invention.
These polymeric materials have an unexpectedly "positive effect" on the tastes and flavors of many divergent prepared foods, beverages and/or on the sensory characteristics of ingredients contained therein. By a "positive effect" is meant the modification of a taste as a result of an increase in a particular defined characteristic such as, fruitiness, and/or a decrease in some undesired characteristic, such as bitterness, sourness, chalkiness, or unpleasant mouthfeel accompanied by an increase in desirable characteristics. For example, in some instances the polymeric polyphenol material may impart additional desirable qualities, such as creaminess, body, mouthfeel/fullness, astringency, a stronger and more lingering taste of a particular flavor, and/or an increase the fruity flavor and improve blendedness of multiple flavors. On the other hand, polymeric polyphenol material may decrease the chalky taste of fat substitutes (i.e., particular in low fat deserts), decrease the sourness of salad dressings and decrease bitterness or an unpleasant mouthfeel of sugar substitutes. Generally, polymeric polyphenol materials improve the overall taste of the foods and ingredients with which they are combined. This is often accomplished at levels below the detection threshold of the polymeric material itself when tasted in simple solutions.
It is well known that flavor, as practically defined in *Sensory Evaluation Technique* by Meilgaard, Civille, and Carr, CRC Press (1999) p. 10, is the sum of aromatics, basic tastes and chemical feeling factors. Basic tastes such as salty or bitter are distinguished from aromatic components such as vanilla. The polymeric polyphenolic materials of the invention generally have a positive effect on various foods and beverages and enhance, alter, decrease, and/or otherwise change the perceived aromatic components, basic tastes, chemical feeling factors and flavors associated with said foods and beverages. This is particularly unexpected because, unlike the relatively few other flavor enhancers which are employed to enhance the flavor of foods, these materials do not have "aromatic" properties of their own at any level of concentration. They have only the intrinsic taste of bitterness and feeling factor of astringency, characteristics already described.

According to the present invention, the flavor modification and positive effect are achieved when used below the detection threshold of the polymeric materials themselves.

Another unusual characteristic of these polymeric materials is their ability to move the perception of some taste characteristics in the mouth so that they are perceived in a different region from where they
otherwise would be perceived. Another unusual manifestation of the materials of the invention is their ability to in spread the taste throughout the oral cavity so that its overall perception is altered either spatially, characteristically, or both. The polymeric polyphenol materials of the invention may also increase (extend) or decrease the length of time a particular flavor or taste is experienced or, indeed, they can blend such effects of different sensory characteristics to present a more appealing or more natural taste in the food or beverage being modified.

It should be noted that the intrinsic sensory properties of polymeric polyphenol materials and especially PPCs in a simple solution include only mouthfeel, astringency and the basic taste of bitterness generally at threshold concentrations of 500 ppm and above. Below these levels even these characteristics are not sensible. By a simple solution is meant a solution of a polymeric phenolic material, such as polymeric proanthocyanidins or other related materials in distilled water and/or, if not if the material is not sufficiently soluble in water, then in an appropriate ethanol/water mixture, such as 20/80 to 95/5 ethanol/water mixture.

In the method of this invention polymeric phenols such as polyproanthocyanidins, or from other sources
must be obtained from oak or polymeric polyphenol materials generally, must be added to a food, a beverage, or an edible consumable in general in an effective amount to enhance, improve or modify the taste or flavor to a desired degree. If an insufficient amount of a polymeric material is added, the taste may not be sufficiently modified to be noticed, especially by some people who may be less sensitive to a particular taste change. If too much of the polymer is added, the modification effect may be lessened or it may cause an undesirable effect.

The optimal amount may be expected to differ for each food or beverage or for each taste or flavor to be modified and the target population. For this reason it is difficult to give one general range of the amount of a polymeric polyphenol that should be appropriately added to foods or beverages in general to obtain the desired modification, improvement or enhancement of a particular taste flavor or sensory characteristic. It is necessary to conduct taste trials to identify the appropriate dose and the preferred range of a polyproanthocyanidin or any other polymeric polyphenolic that should be added to a particular food or beverage to give the desired sensory results. It, nevertheless, may be generally stated that to a solid food it may be desirable to add at least 1 ppm and up to whatever amount produces the
desired level of modification. Generally it may be appropriate to add 0.0005% to 0.10% by weight (5 ppm to 1,000 ppm) and preferably from 0.00075% to 0.05% by weight (7.5 ppm to 500 ppm). Often 0.001% to 0.025% by weight (10 ppm to 250 ppm) is a useful and effective amount. The amount that is often effective in liquids is at least 1 ppm, but generally from 5 ppm to 500 ppm, often from 10 ppm to 100 ppm.

The addition of 10 ppm to about 2,000 ppm or more of a PPC or any other polymeric polyphenol material to a food or beverage other than wine will generally result in an improvement in the astringency/bitterness ratio as well as the modification and enhancement of flavor and other sensory properties of such a food or beverage. If the primary aim is to increase the astringency/bitterness ratio, it will be generally necessary to add at least 500 ppm of the polymeric modifier. If the foods or beverages naturally contain some amounts of polymeric polyphenol materials, the above-indicated amounts should be added in addition to the amounts naturally present.

Generally, the addition of from about 1 ppm to about 2,500 ppm and more often from about 5 ppm to about 1,000 ppm and conveniently from 10 ppm to 750 ppm of a polymeric polyphenol material such as a PPC to a beverage containing 0.1% alcohol up to 80% alcohol by volume, or from 2.0% to 40% alcohol, will
alter and/or improve the sensory characteristics of a beverage.

The polymeric polyphenol materials generally improve the taste of an artificial or high intensity sweetener composition. Such low calorie sweeteners include aspartame (L-aspartyl-L-phenylalanine methyl ester), acesulfame, thaumatin, chalcone, cyclamate, stevioside, neohesperidin, N-cyclohexyl sulfamic acid and other known sweeteners, and especially saccharin.

The taste of those sweeteners which, as an element of its flavor profile, has a metallic and bitter component to its sensory profile or a too rapid rise in sweetness or a too slow decrease in sweetness after tasting, or a sensation in a region of the mouth not conducive to optimal perception, can be substantially improved by incorporating therein an effective amount of a polymeric phenolic material of the invention, such as a PPC. This will generally depress the metallic and bitter aftertaste of a sweetener and/or alter its other sensory elements to improve its overall perception and taste. The actual amount of a polymeric polyphenol material needed to improve the taste of an artificial sweetener will depend on the specific sweetener, and its concentration and intended use, but generally the amount will be at least 1 ppm and up to about 500 ppm or more based on the weight of the sweetener, more often in the range of from about 5
ppm to about 200 ppm and often in the range of from about 5 ppm to about 10 ppm. For some sweeteners 10 ppm to about 50 ppm is found to be effective.

Polymeric polyphenol materials such as polyproanthocyanidins are generally considered to have limited solubility in aqueous solution, depending on the specific nature of the monomeric unit and on the molecular weight and conformation, functional substitution, crosslink density, and other structural elements of the polymer. However, such solubility may be usefully altered and increased by the use of mixed solvents such as ethanol/water, water/ethyl acetate or other acceptable mixtures and/or by altering and controlling the temperature and other conditions under which solvation is achieved. Although it may be possible to obtain an aqueous solution of a polyproanthocyanidin at very low concentration under a number of conditions, and even at usefully high concentrations under other conditions, it is often more practical to prepare a solution of the polymer in ethanol or an ethanol/water mixture containing 20 to 95% by volume of ethanol.

Generally, a solution containing of from 1% to 10.0% by weight of a plant extract such as a grape seed extract or a polymeric oak extract which may constitute largely a polyproanthocyanidin, or a polymeric polyphenolic material in general, and more usually of from 0.10% to 5% by weight, can be prepared in an ethanol/water mixture containing 50% water and
50% ethanol (95%). The concentration of the polymer in the ethanol/water mixture is not important, as the solution is only a useful vehicle for incorporating the PPC or other polymeric polyphenolic into a food or a beverage. The actual concentration will generally be dictated by the degree of solubility of the polymer, the percentage of ethanol in the mixture and the convenience of adding the solution of the polymer to the food or beverage system.

It was mentioned earlier that there is a substantial difference in the taste modifying properties of polyphenolic monomers, oligomers and polymers. One example of such difference is in the astringency/bitterness ratio of each type of these polyphenolic materials as shown in the table below.

Eighteen panelists (mean age: 27.4 years; range: 21 - 45 years; 9 males and 9 females) were selected and trained in two sessions to assess astringency, bitterness and sourness. Although sourness was not assessed in this particular evaluation, training for sourness reduced the likelihood of sourness/bitterness confusions by the panel. Without this training such confusions are otherwise common and could result in erroneous ratings. The majority of the panelists had previously served on other trained panels or in psychophysical experiments. Eight of the panelists had also participated in the previous study assessing the impact of rinses on the build-up of astringency. The ballot utilized was an ASTM approved scale titled:
Magnitude Scale.

**Ratio of Astringency / Bitterness of Monomer, Oligomer, and Polymer**

**In Water:**

<table>
<thead>
<tr>
<th>Concentration (ppm)</th>
<th>Monomer</th>
<th>Oligomer</th>
<th>Polymer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>0.54</td>
<td>1.00</td>
<td>1.96</td>
</tr>
<tr>
<td>2000</td>
<td>0.67</td>
<td>0.95</td>
<td>2.13</td>
</tr>
</tbody>
</table>

**In Alcohol (9%)/Water:**

<table>
<thead>
<tr>
<th>Concentration (ppm)</th>
<th>Monomer</th>
<th>Oligomer</th>
<th>Polymer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>0.42</td>
<td>0.50</td>
<td>0.86</td>
</tr>
<tr>
<td>2000</td>
<td>0.53</td>
<td>0.60</td>
<td>1.20</td>
</tr>
</tbody>
</table>

The data in the above table shows that, at a given concentration, there is some improvement in the astringency/bitterness ratio observed from the monomeric to the oligomeric PCs, but there is a dramatic improvement in the astringency/bitterness ratio from the OPCs to the PPCs. In other words, bitterness in relation to astringency is less pronounced in PPCs compared to OPCs.

The above-discussed improvement of the astringency/bitterness ratio can particularly be taken advantage of in wines. In general, white wines contain no measurable MPCs, OPCs or PPCs while red wines usually contain a very small amount of MPCs and after aging may contain a slight amount of OPCs, but hardly any PPCs, that is, a material which is chromatographically eluted at the same time as the
high molecular weight PPC materials of this invention. Therefore, if in white or red wines it is desirable to increase astringency (without increasing the bitterness), polymeric polyphenol materials such as PPCs may be added at levels where their intrinsic sensory characteristics may be manifested and perceived, that is, generally above 500 ppm and up to 4,000 ppm or even higher, but usually between 500 ppm and 2,500 ppm. Such addition of the high molecular weight PPCs will generally not only increase the astringency/bitterness ratio of a wine, but also modify the flavor properties and mouthfeel. When it is desirable to enhance or modify the taste, flavor, mouthfeel or some other sensory characteristic of a wine, it may be sufficient to add from about 5 ppm to about 250 ppm of a polymeric polyphenol material such as a PPC. It is important to note that such enhancement and modification of a wine is achieved when said amounts of a polymeric polyphenol material, and especially of a PPC, is added in addition to whatever amount of such materials may be naturally present in a wine, particularly red wine. The natural occurrence of such polymeric materials in red wine may be as a result of aging or may be naturally coming from grapes or oak.

Examples of various categories of foods and beverages that may be improved, modified, extended or enhanced in taste by the addition of an effective
amount of a polyproanthocyanidin or other polyphenolic polymers are mentioned below.

1) **Brown Foods** - Examples of this class of flavors includes coffee, tea, chocolate, maple, and brown sugar. The polyproanthocyanidins or other polyphenolic polymers can enhance the flavor of chocolate, coffee, tea, brown sugar and maple by increasing the intensity of each flavor and by having a lingering effect, the consequence of which is that the taste lasts longer. Examples of brown flavors in utilized food systems include: chocolate pudding, yogurt, ice cream, instant coffee, hard candy, chocolate candy, powdered tea drinks, ready to drink teas, etc. The appropriate amount of a polyphenolic polymeric material, such as a PPC or a polymeric oak extract, in a brown food is at least 5 ppm and generally from 0.001% to 0.1% (10 ppm to 1,000 ppm) and more often from 0.0025% to 0.05% by weight (25 ppm to 500 ppm).

2) **Dairy Products** - This class includes such foods as cheeses, yogurt, milk, ice cream, and the like. PPCs can add blendedness and creaminess to the various dairy products, while decreasing the sharp notes of the short chain volatile acids. This is especially noticeable in low-fat systems where the milk/dairy notes are enhanced and extended. The effective amount of polymeric polyphenol materials,
(including PPCs or materials derived from oak or other sources, in a dairy product is at least 5 ppm and generally from 0.001% to 0.10% (10 ppm to 1,000 ppm) and more often from 0.0025% to 0.05% by weight (25 ppm to 500 ppm).

3) **Various Grape and Non-Grape Based Alcoholic Beverages** - Such low-alcohol beverages as beers, and wines and higher alcoholic content beverages such as brandies, scotch and liquors may be improved or enhanced by the addition of polymeric polyphenol materials, especially PPCs. Illustrative examples of such alcoholic beverages are mentioned below:

   (a) **The wine category** - This category includes both wines at full alcohol (9-18%) and wine-based beverages of lowered alcohol (4-9%), including wine coolers. It is well known that wines differ in quality and in taste depending on the type of grapes used to make the wine, the geographic area where the grapes grow, the soil, the amount of sun and rain, the temperature variation and other variables. A particular wine in a particular year can be great, very good or merely mediocre. For these reasons occasionally some wines may be deficient in some flavor attribute, and it would be most helpful to a winemaker if such a deficiency could be corrected.

   The use of a polymeric polyphenol material, such as a polyproanthocyanidin or a polymeric oak extract, can unexpectedly modify, improve or enhance certain
taste, flavor and sensory characteristics to improve the quality of wine. Wines can be made to have increased complexity, taste more blended, more full-bodied, as well as what is generally described as more aged. For example, the panelists who participated described the wine with the added PPCs as having changed from a red fruit to more of a brown fruit/aged.

Similarly, a polymeric polyphenol material such as a polyproanthocyanidin can alter, generally improve, the body and mouthfeel. If, for example, the wine is thin its body and mouthfeel can be improved by the addition of a polymeric polyphenol material. This may be accomplished by adding to a wine at least 1 ppm and generally from 0.0001-0.1% by weight (1 ppm to 1000 ppm) of a polymeric polyphenol material, such as a polyproanthocyanidin or a polymeric oak extract; often from 0.0005 % to 0.05% (5 ppm to 500 ppm) and most often from 5 ppm to 200 ppm. The amount of a polymeric polyphenolic actually added will depend on the type of wine used, the particular feature that is being modified and the desired level of modification in the taste or other sensory characteristic. Therefore, certain level of experimentation is necessary in determining the preferred amount to be added.

A bench-top tasting was conducted with five untrained panelists using 1996 Turning Leaf®
Chardonnay, with one set of samples containing 30 ppm of a polymeric oak extract. All five tasters noticed an increase in blendedness, a decrease in the sharp alcohol character, and an increase in mouthfeel.

(b) **Low-alcohol beverages** - This invention is particularly useful in improving and enhancing the taste and other sensory characteristics of low alcohol or flavored wines. The low alcohol wine beverages generally will contain from 0.1% to 10% by volume of alcohol, often from 2% to 9% of alcohol and usually from 2% to 6% of alcohol. Such beverages are generally made from wine or malt or other neutral spirit by using, for example from 20% to 80% of wine and the balance may be an appropriate fruit juice or a mixture of fruit juices, water, sugar or other sweeteners such as fructose, corn syrup, invert syrup, refiners syrup, maltose and high maltose syrups and mixtures thereof, and other natural and artificial flavors and colors. Such beverages include wine coolers, flavored and composed wines and the like.

These low alcohol content beverages generally may have a sweet, watery, overly fruity taste and thin mouthfeel without much body and sophistication. By adding at least 1 ppm and generally about 0.0001 to about .01% (1 ppm to 1,000 ppm) by weight of a polymeric polyphenol material, such as a polyproanthocyanidin or a polymeric oak extract, and
more often from 0.0005\% to about 0.055\% (5 ppm to 500 ppm) and conveniently from about 0.0005\% to about 0.02\% (5 ppm to 200 ppm) of a polymeric polyphenol material in the above described low alcohol content beverages, the above listed deficiencies and other taste and sensory parameters, such as blending of flavors, can be substantially improved and enhanced. Furthermore, the polymeric polyphenol materials can add a significant component of higher alcohol content taste without actually increasing the alcohol content.

c) High alcohol beverages - Spirits are high alcohol content beverages, such as brandies, scotch, bourbon and liqueurs, usually containing from about 18\% up to about 80\% and often from 20\% to 50\% by volume of alcohol. Spirits have generally not been the subject of improvement once they have been made. Surprisingly, this invention is capable of improving, modifying and/or otherwise enhancing the quality of this type of an alcoholic beverage by incorporating therein an effective amount of a polyproanthocyanidin or other polymeric polyphenolic. Some brandies, scotch, bourbon and liqueurs, especially the less expensive type, may be somewhat harsh or bitter in taste and have an overpowering, sharp and unpleasant taste of alcohol. The taste and other sensory traits of such alcoholic beverages may be improved and the desirable taste enhanced by the addition of at least 1
ppm and generally from 0.0001% to about 0.10% by weight (1 ppm - 1,000 ppm) of a polymeric polyphenol material, such as a polyproanthocyanidin or a polymeric oak extract, and often from about 0.0005% to about 0.05% (5 ppm - 500 ppm). Liqueurs and other fruit extract-containing alcoholic beverages may also be improved in taste. The addition of from about 0.0001% to about 0.10% (1 ppm - 1,000 ppm) by weight and often from about 0.0005% to about 0.05% by weight (5 ppm - 500 ppm) of polyproanthocyanidin or other polymer polyphenolic is particularly effective in enhancing and prolonging the taste of the fruit or fruits used to make the liqueur.

A bench-top tasting was conducted with four untrained panelists using the following four brandies: E & J® Brandy (California), Rémy Martin® Cognac VSOP (French) and J. Dupery® Armagnac (French) with one set of samples containing 20 ppm of a PPC. All four panelists noticed an improvement in the quality of taste in the three brandies containing PPC, stating that the brandy samples with PPC were smoother, had less alcohol bite and tasted milder.

4) **Artificially Sweetened Finished Foods** - Artificial sweeteners have become important ingredients in desserts because, although they add almost no calories to the dessert, they provide a strong taste of sweetness. Examples of artificial
sweeteners are aspartame (L-aspartyl-L-phenylalanine methyl ester) which is sold in combination with dextrose and maltodextrin as Equal, saccharin, acesulfame, thaumatin, chalcone, cyclamate, stevioside, neohesperidin dihydrochalcone, N-cyclohexylsulfamic acid and the like. A difficulty with the artificial sweeteners is that generally they have a lingering metallic or bitter aftertaste. This unpleasant and undesirable bitter aftertaste is either completely eliminated or at least substantially decreased by the addition of at least 0.1 ppm and generally from about 1 ppm to about 1,000 ppm by weight, (based on the weight of the finished food) of a polymeric polyphenol material, such as a polyproanthocyanidin or a polymeric oak extract, and often from about 1 ppm to about 500 ppm or even 250 ppm. The most surprising effect of polymeric polyphenols on the artificial sweeteners is that they not only reduce the bitterness but also reduce the prolonged and unpleasant sweet aftertaste of such sweeteners.

5) Dietetic or Low Fat or Fat-Free Foods - These foods of many types can particularly benefit from the present invention. The low fat or fat-free desserts include frozen desserts, such as ice cream, ice milk, sherbet, frozen yogurt, frozen custard, sorbet, ices, tofutti and imitation ice cream. Other dietetic
desserts may include, for example, puddings, mousse, cakes, pies, gelatin desserts and the like. To reduce the caloric content of a dessert generally an artificial sweetener is substituted for sugar (sucrose). In desserts, sugar not only provides the sweetness but it also acts as a bulking agent. Since, for example, the artificial sweetener Aspartame is about 200 times as sweet as sugar, it would be easy to replace all the sugar in the desserts by adding a relatively small amount of Aspartame. The reduction of volume would, however, have a deleterious effect on the structure of the dessert, causing the mouthfeel to be inferior. For this reason whenever all or most of the sugar is replaced by an artificial sweetener, it is necessary to replace the bulk normally provided by the sugar by substitute bulking agents. Available bulking agents are carbohydrates which cannot be metabolized, such as polydextrose alone or in combination with minor amounts of sugar alcohol or enzymes such as rennet, carboxymethyl cellulose or carboxymethylcellulose, tofu (soybean protein) and others that are well known in the art.

Traditional desserts also normally contain a substantial amount of fats which provide a pleasant mouthfeel and creaminess to a dessert. In low-fat or fat-free desserts the fat is usually substituted by
low caloric fats, such as lipifats, sucrose polyesters (a mixture of hexa-, hepta- and octa-esters formed by the reaction of sucrose with long chain fatty acids) and other low or non-caloric materials known to the trade. These non or low-caloric fats and sucrose polyesters are not metabolized and are thus a means to reduce the caloric content of a dessert.

The bulking agents and the fat substitutes, however, do not provide the creaminess and the mouthfeel that are present in a traditional dessert. The dietetic desserts, whether frozen or in other forms, generally possess unpleasant chalky, sometimes somewhat gritty mouthfeels, tastes, and textures. Such negative sensory characteristics may be substantially improved by the addition of a polymeric polyphenol material in the dietetic, low fat or fat-free foods of at least 1 ppm and generally of from about 0.0001 to about 0.1% by weight of a dietetic, low-fat or fat-free food (1 to 1000 ppm). Useful amounts of polymeric polyphenol materials such as PPCs may be more often in the range of from 10 ppm to 500 ppm or even 250 ppm.

6) Artificial Sweeteners - The compositions encompassed by the invention and containing superior taste properties are the artificial sweetener compositions, that is, an active sweetener compound, a carrier such as starch, dextrose, maltodextrine or other materials of this type sweetener and an
effective amount of a polymeric polyphenol material, such as a PPC or a polymeric oak extract composition. The active sweetener ingredient may be selected from known materials exemplified above. An effective amount of a polymeric polyphenol material that may be used in a sweetener composition will depend to a large extent on the specific sweetener used, on the intended application of the sweetener and on the particular feature (taste characteristic) of the sweetener that one wishes to modify. It is well known that some artificial sweeteners are more bitter than others and that some exhibit an overly-strong and/or overly-long sweet aftertaste. Generally, all of these taste characteristics can be modified by incorporating in a sweetener an effective amount of a polymeric polyphenol material such as at least 0.1 ppm and generally from about 0.5 ppm to about 1,000 ppm based on the weight of the sweetener and often from 1 ppm to 500 ppm or even 250 ppm, but different ranges may be more appropriate with specific sweeteners. For example, in a saccharin composition the preferred range is from about 50 ppm to about 250 ppm or even from 10 ppm to 150 ppm, while with Nutrasweet the range is from about 5 ppm to about 400 ppm and preferably from about 10 ppm to about 250 ppm and often from 15 ppm to 150 ppm based on the weight of the sweetener.
7) **Non-Alcoholic Beverages** - Various fruit and berry juices and drinks can also be substantially improved in flavor/taste and overall blendedness by incorporating at least 1 ppm and generally from about 0.0005% to about 0.1% (5 ppm to 1000 ppm) by volume of a polymeric polyphenol such as a polyproanthocyanidin or a polymeric oak extract and often from 10 ppm to 500 ppm. If such beverages are sweetened by an artificial sweetener, their taste is substantially improved because a polyproanthocyanidin or, another polymeric polyphenolic reduces or eliminates the bitter and overly sweet aftertaste as was mentioned above. The polymeric compositions of this invention will also add the desirable characteristic of astringency and other desirable features.

Polyproanthocyanidins and other polymeric polyphenolics, however, also enhance/deepen the flavors and make the flavors of the berries more like real fruit, as well as increasing the flavors in the aftertaste. For this reason this invention is also applicable to the improvement and enhancement of the taste of a variety of fruit and berry juices and drinks, and particularly if they have been sweetened by an artificial sweetener.

Basic tastes are sweet, sour, salty, umami, bitter. The psychophysics of the basic tastes is such that the relative threshold of the tastants is different, and their perception changes with
concentration. However, the current invention modulates the perception of the basic tastes at levels above the threshold of the taste being modified and below the threshold of the polymeric polyphenol materials.

The modification in taste can be a decrease, increase, and/or a modulation of the time intensity profile of a given flavor or taste. For example, in the presence of a polymeric polyphenol material such as a PPC, the panelists perceived bitterness faster, but the bitter aftertaste was shortened (no linger). At the same time, at low measured levels of bitterness associated with caffeine, the PPC can potentiate the basic taste of bitter at levels well below those associated with its own taste component. This is shown in Fig. 1 below. However, in complex food systems, a decrease in bitterness of tonic water (quinine being the active bitter agent) has been observed with the addition of PPC. This was assessed using the ASTM method described below and the result is shown in Fig. 1 below.
Fig. 1

Figure 1. The effect of the PPCs on bitterness of caffeine (basic taste solution) and quinine (beverage system).
The Flavor Profile Method is an ASTM approved method for the description and assessment of the aroma and flavor of a product in a reproducible manner. The separate characteristics contributing to the overall sensory impression of the product are identified and their intensity assessed in order to build a description of the aroma, flavor, and aftertaste of the product. The descriptive analysis usually includes: overall impression, identification of perceptible aroma and flavor character, intensity of each character note, order in which these notes are perceived, and aftertaste. Four trained panelists were utilized for the assessments. This method was used for the assessment of aroma and flavor of foods and beverage systems.

Shown in Fig. 2 is the effect of PPC on the Paisano® wine. Modulation of the responses to chemical irritation also occurs.
Figure 2. The effect of the PPCs on balance, fullness, and sourness in 12% alcohol Paisano® (beverage system)
Trigeminal stimulus such as capsaicin heat can be modified/intensified by the addition of the PPC. In addition, there is an alteration in where the heat is perceived in the mouth. Traditionally, capsaicin heat is perceived at the tip of the tongue and back of the throat. With the addition of the PPC, the heat is perceived on the surface of the tongue. Similar effect has been observed with respect to other oral irritants, including alcohol, such as increase in alcohol burn associated with brandy and full alcohol wine.

Modulation of sourness: In model solutions, sourness has been shown to be decreased with the addition of PPC. However, in complex food systems, sourness has been shown to sometimes be potentiated and other times decreased. Examples include the potentiation of sourness in alcoholic beverages, (10-12% alcohol) and soups and decreased in sourness of reduced fat salad dressings as shown in Figure 3.
Figure 3. The effect of the PPCs on sorness of citric acid (basic taste solution), lowfat chicken broth (food system), ranch dressing (food system), and wine (beverage system).
Modulation of Sweetness: In model solutions, sweetness has been shown to be potentiated by the PPCs. However, in complex food systems there is either no change in sweetness or a decrease in sweetness. Examples in which the sweetness did not change include lemon drink, chocolate milk, salad dressing, and chicken broth as shown in Fig. 4 below.
Figure 4. The effect of the PPCs on sweetness of sucrose (basic taste solution), chocolate milk (beverage system), salad dressing (food system), lowfat chicken broth (food system), and lemon drink (beverage system).
Examples where sweetness decreased include wine cooler type products (4 to 6% alcohol, 5-6% of residual sugars), Nutrasweet and saccharin flavored products and jams (including light versions).

Modulation of saltiness: Utilizing model solutions, saltiness was shown to be enhanced by the PCPs. In complex food systems, saltiness was shown to be potentiated in low-fat chicken broth, while it was shown to decrease saltiness in a cheese product such as Cheez Whiz® as shown in Fig. 5.
Figure 5. The effect of the PPCs on saltiness of salt (basic taste solution), lowfat broth (food system), and Cheez Whiz(R) (food system).

<table>
<thead>
<tr>
<th>Sample</th>
<th>4.25</th>
<th>4.5</th>
<th>4.75</th>
<th>5</th>
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<tr>
<td>Chicken Broth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheez Whiz</td>
<td>5.75</td>
<td>5.25</td>
<td>5.5</td>
<td>5.75</td>
</tr>
<tr>
<td>Basic Taste Solutions-Salt</td>
<td>4.75</td>
<td>4.75</td>
<td>4.5</td>
<td>5.25</td>
</tr>
</tbody>
</table>

Table of rankings:

- Chicken Broth
- Cheez Whiz
- Basic Taste Solutions-Salt

Sample: control, 10 PPM, 25 PPM, 50 PPM, 100 PPM.
Modulation of Umami: Umami is the brothy or mouth-filling sensation brought about by potentiators such as MSG. When tested in a simple solution, MSG was found to be potentiated by the PPCs. The same was true in a more complex food system. This is most unusual and unexpected in that PPCs demonstrate the property of potentiating and enhancing the enhancement properties of the only currently known and widely used class of flavor enhancers. Given that many users react negatively to MSG as it is known to induce unpleasant side effects, the use of PPCs or other polymeric polyphenol materials in combination with MSG to provide a synergistic flavor enhancement represents an important and separate aspect of invention. This unexpected enhancement of the effectiveness of MSG by polymeric polyphenol materials will enable the reduction in the amount of MSG required to achieve the desired taste enhancement effect in a particular food product. The amount of a polymeric polyphenol material required to provide the synergistic effect in combination with MSG will depend on the type of food where it is incorporated and in the degree of the desired effect. Generally a polymeric polyphenol material such as a PPC may be employed at a concentration of at least 0.1 ppm based on the weight of MSG. A polymeric polyphenol material may be used in the amount of up 59 1,000 ppm or more based on the
weight of MSG, but generally up to 500 ppm or even 250 ppm is sufficient. Often the useful amount may be from 0.5 ppm to 200 ppm or even 100 ppm of a polymeric polyphenol material, depending on the type of food taste that is being enhanced.

PPCs also potentiated the fullness of the cheese product and the fat-free chicken broth as shown in Fig. 6.
Figure 6. The effect of the PPCs on mouthfeel and fullness of Cheez Whiz® (food system) and chicken broth (food system).

<table>
<thead>
<tr>
<th>Sample</th>
<th>control</th>
<th>25PPM</th>
<th>50PPM</th>
<th>100PPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cheez Whiz-Mouthfeel</td>
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<td>3.75</td>
<td>4</td>
<td>4.25</td>
</tr>
<tr>
<td>Cheez Whiz-Fullness</td>
<td>3.5</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Chicken Broth-Mouthfeel</td>
<td>3.25</td>
<td>3.25</td>
<td>3.75</td>
<td>4</td>
</tr>
<tr>
<td>Chicken Broth-Fullness</td>
<td>3.25</td>
<td>4</td>
<td>3.75</td>
<td></td>
</tr>
</tbody>
</table>
Polymeric polyphenol materials including polyproanthocyanidins may be extracted from a variety of plants including grape seeds, grape skins, grape stems, pine bark, lemon tree bark, cranberries, green tea, hazel nut tree leaves, blue berries, cherries, strawberries, apples and other fruits as well as from grains such as barley. The most important sources of such polymers are various parts of the grape, especially seeds, stems and skins.

In the natural product, the polymeric proanthocyanidins and polymeric polyphenolics in general, exist in mixtures with many other materials which are either not useful in the modification of taste and flavor or may contain impurities which result in negative taste and flavor attributes. In their native state the polymeric polyphenolics, such as proanthocyanidins, may represent only a few percent (1-2% and possibly up to perhaps 25%) of the total mass of the plant material. Furthermore, the exact amount and fraction may vary by plant variety, growing and soil conditions, the use or non-use of fertilizers and pesticides, and seasonal variations in weather. For example, procyanidins represent about 0.5-1.0% by weight of the mass of a typical grape. The grape seed is the best source of such materials.

The crude extract of a polymeric polyphenol material such as a PPC is obtained by extraction
according to known methods. The processes for obtaining the crude extract are characterized by the following steps for catechin based polymers (including PPCs from grape seed) and may be extended to all polymers of the polyphenolic class obtained from various other plant matter.

Extraction of the proanthocyanidin-containing polymeric material can be accomplished with various mixtures of water and acetone or ethanol or after acceptable solvents. For example, various aqueous ethanol solutions containing up to 100% ethanol may be used, but preferably 95% ethanol is used as the extraction solvent. Thereafter the polymeric material may be isolated by a number of available methods, such as precipitation, evaporation or by processing through a membrane. If precipitation is not used for isolation, 20% or 10% ethanol or even water alone may be employed as the aqueous solvent. If the solutions contain no ethanol or a low content of ethanol (e.g. up to 40%), longer exposure times and higher temperatures are required to obtain the maximum yield of polymeric polyphenol materials such as PPCs from the plant material.

The following methods may be used for the isolation of the extracted polymeric polyphenolic materials.

a) Precipitation - The extracted polymeric material
contained in an organic solvent, such as 95% ethanol, may be precipitated by the addition of an acceptable hydrophobic precipitant such as liquid propane, supercritical CO₂ or, preferably, hexane. The precipitate settles, or may be centrifuged or filtered under suitable conditions. The resulting precipitate will contain enhanced and concentrated polymeric polyphenol materials of at least 40% by weight of polymers, 25-50% of monomers and oligomer, and 25-40% of other impurities. Thus at this stage of isolation the ratio of the polymeric fraction to the monomeric/oligomeric fraction may be from 1: 0.6 to 1: 1.25. As the stepwise purification is continued and the relative concentration of the polymeric fraction increases while that of the monomeric/oligomeric fraction decreases, this ratio will change proportionately. The new ratios of the polymeric fraction to the monomeric/oligomeric fraction may be in the range of 4: 1 to 8: 1 to 16: 1 to 100: 1 and even 200: 1.

The solvents and precipitants chosen must be compatible with each other and, from a practical standpoint, must be acceptable for food grade processing. Hence, any solvent and any precipitant having current GRAS approval and/or currently used and accepted in the production of foods (e.g. ethyl acetate) may be useful in the extraction and
separation, provided that it can dissolve the desired material under conditions which do not degrade its useful properties.

b) Evaporation - The extracted material contained in an organic solvent may also be isolated by evaporating the organic phase under vacuum. Any remaining water must be removed under conditions sufficiently mild to avoid undesirable chemical changes in the extracted polymeric proanthocyanidins or other polyphenolics. Freeze-drying of the extract to remove water is the method of choice, but other methods such as spray drying at any acceptable temperature which does not harm the extracted material, or negatively impact its useful properties, are also useful. In this regard 75-85 degrees C may be a useful maximum temperature.

c) Membrane Separation - Ultrafiltration membranes may be used to isolate the crude polymeric polyphenol materials. This method first requires the removal of the undissolved matter such as by filtration or by centrifugation and thereafter passing the liquid through an ultrafiltration membrane designed to separate biomolecules by molecular weights. An example of a useful membrane is Amicon YM3 which will not pass molecules with a nominal molecular weight above 3,000. Thus the monomeric, oligomeric and other low molecular weight impurities will pass through the membrane and the polymeric polyphenol materials will
stay behind, isolating them for further use or purification.

The isolated crude extract will contain polymeric proanthocyanidins or other polyphenols as well as a wide mixture of the monomeric, oligomeric and many undesirable impurities. It contains at least 40% by weight of polymeric polyphenol materials such as PPCs and often it may contain higher amounts of the desired polymeric materials, such as at least 50% or even at least 60%. Because of the enhanced amounts of polymeric polyphenol materials the crude extract may be generally suitable for specific applications in the modification of edible consumables, especially if a moderate level of bitterness may be tolerated.

Further purification is necessary to remove most of these undesirable materials.

For some taste and flavor modifying applications it may be advantageous to employ a mixture of a prior art plant extract, and particularly a grape seed extract, such as a commercial product ACTIVIN™, and an isolated crude extract of polymeric polyphenol materials continuing at least 40% of polymeric polyphenol materials and preferably a purified polymeric material of this invention containing at least 50% and more preferably at best 60% of polymeric materials or at least 70% or even 90%. A prior art extract such as ACTIVIN contains up to about 2.5% by
weight of monomeric PCs, 40-55% of OPCs, 10-15% of polymeric polyphenol materials and the balance of undesirable impurities. Although any mixture of a prior art extract and of the polymeric polyphenol materials of this invention may be useful, it is preferable that at least 50% by weight of the polymeric materials of this invention be employed.

In most instances, however, purified polymeric polyphenol materials such as PPCs may be preferred or required. The high polymer content, purified polymeric polyphenol materials represents one aspect of the invention. The purified polymeric polyphenol materials such as PPCs may be obtained by one or more of the following methods, or by a combination of these methods.

Such purification methods may include: two phase solvent extraction by using a combination of acceptable solvents. One of the two solvents should primarily dissolve the desirable polymeric materials and the other solvent should primarily dissolve the undesirable impurities and the MPCs and OPCs. Examples of such solvents are an alcohol including butanol, pentanol, hexanol, heptanol or octanol and water; and ethyl acetate and water. Such mixtures may be in ratios from 1:10 to 10:1 with a 1:1 being very useful. Other methods include successive dissolving
in a solvent and precipitation, membrane processing and chromatographic adsorption.

An inventive polymeric polyphenol material purification method yielding polymeric polyphenolic materials that contain minimal amount of impurities and small amounts of monomeric oligomeric polyphenolics, comprises: a) dissolving the crude isolate in an acceptable solvent, which may be the same or different from the solvent previously used; b) precipitating the polymeric polyphenol material by the addition of an acceptable precipitant; c) redissolving the precipitated material and d) passing the solution through a chromatographic (selective sorption) column.

Said purification process may be described in greater detail as follows:

a) Dissolving the dried extract of proanthocyanidins or other polyphenolics in an aqueous solvent containing preferably 95% ethanol, but possibly also containing more or less of such a solvent, up to 100% ethanol, and filtering the solution in order to remove solid particles;

b) adding hexane or some other suitable precipitant to the filtered solution to precipitate the PPCs or other polymeric polyphenol materials;

c) isolating the precipitated material by methods such as filtration, centrifugation, or settling;

d) redissolving the separated residue in 80 to 98% aqueous ethanol, but preferably 95% ethanol;
e) repeating the precipitation until a composition of desired enrichment and purity is obtained;
f) mixing the ethanol solution of PPCs or other polymeric polyphenolics enriched in polymeric content with an adsorbent, such as a hydroxypropylated dextran. An example of such an adsorbent being Sephadex LH 20, but any material may be employed in this step provided it will adsorb the polymeric materials. The mixture then is stirred until most of the PPCs are adsorbed onto the adsorbent. Any other method of mixing the solution of polymeric polyphenolic material with the sorbent could also be employed such as recirculating the resin through a well-distributed packed bed of resin;
g) washing the solution containing the absorbed PPCs with a solvent that disrupts the adsorption effect between the resin and the undesirable materials which are adsorbed on the column, such as sugars, glucosides, organic acids or highly oxidized proanthocyanidins or polyphenolics, and even some small portion of the lower molecular weight oligomers and monomers. However, this wash solvent must minimally disrupt the adsorption between the adsorbent and the PPCs or other polymeric polyphenol materials of the invention. This allows the removal of these undesirable materials while retaining on the adsorbent the desirable PPCs or other polymeric polyphenol materials. Appropriate wash solutions are water, ethanol or mixtures thereof containing from 40% to 70%
of ethanol, and usually a mixture of 60/40 of ethanol and water.

The wash solutions, usually aqueous ethanol that may be applied to the absorbent resin at various stages of the purification procedure, may be collected separately and combined. This solution will contain mostly the undesirable impurities, MPCs and OPCs, but it will also contain some useful polymeric polyphenol materials that were not absorbed by the resin. By employing the above described purification steps such as evaporating the solvent, dissolving the remaining solid and precipitating the desired fraction, additional polymeric polyphenol materials may be isolated.

h) applying a stripping solution for the purpose of recovering the adsorbed polymeric polyphenolic material from the sorbent. Preferably this stripping solution contains aqueous acetone, which disrupts the interaction between the adsorbed polymeric polyphenol materials and the sorbent, thereby desorbing the polymeric polyphenol material and allowing them to be collected. The most useful solvents for achieving the specified desorption are aqueous ketone containing solutions, with acetone being preferred, because of its wide use in the food industry. Aqueous acetone containing from 40 to 70% of acetone, or preferably a 60/40 mixture of acetone and water, are most desirable. However, other concentrations and even
other miscible additives to the water solution are possible;

i) the separated and desirable polymers of the invention may be dried substantially at various stages of purification described above, depending on the desired degree of purity. The dried material will generally contain less than 8% water and preferably less than 5% of water and most preferably less than 1% of water, yielding the dried PPC or other polymeric polyphenol material compositions of this invention.

Various fractions of the isolated and partially purified polymeric materials, such as Eluate I and Eluate II (as explained in detail in Example 3) may be recombined, especially after processing Eluate I to remove the impurities which are co-recovered. Eluate I was found to contain the highest molecular weight and consists of about 60% of the PPCs or other polymeric polyphenol materials present in the crude precipitate. It has an impurity content of between 10% and 30%, again depending on the feedstock and many other factors. Thus Eluate I has a higher molecular weight than Eluate II, but also a higher impurity content.

Generally Eluate II contains at least 70% of the polymers of the invention, but it may contain, especially after several purification steps, very high purity polymer content of up to 95%, 98%, 99% or even 99.5% polymer of the invention, with little measurable impurity, MPCs or OPCs.
Membrane Processing - The precipitated and redissolved crude extract may also be purified by processing the solution through an appropriate ultrafiltration membrane, such as for example passing it through an Amicon YM3 membrane, in place of sending the solution through an adsorption column.

The PPC or other polymeric polyphenol material compositions extracted and purified as described above can be characterized by the following methods:

**High Performance Liquid Chromatography** - lower molecular weight MPCs and OPCs are resolved as distinct peaks in the chromatogram and are easily distinguished from the PPCs that elute, according to the conditions and on the column described in the example, as a broad peak between 35 and 65 minutes under the conditions described below:

1) catechin peak (approximately 26 minutes);

2) and the epicatechin peak (approximately 41 minutes);

3) and the proanthocyanidin dimer peak (approximately 22 minutes);

4) and the proanthocyanidin dimer peak (approximately 35 minutes);

5) and the proanthocyanidin trimer peak (approximately 47 minutes);

6) and the PPCs hump (approximately 45 to 75 minutes).

The above elution times were obtained under the following chromatographic conditions:
1) Instrument: Hewlett Packard HP 1100 Series

2) Column: Zorbax SB-C18, 4.6 x 150mm, 3.5 micron, 80 A pore size

3) Column Temperature: 30C

4) Column Pressure (max): 200 bar

5) Solvent gradient:
   Solvent A: 2.5% acetic acid in water
   Solvent B: 80% acetonitrile in solvent A
   0-3 min 3% solvent B
   3-25 min 9% solvent B
   25-35 min 11% solvent B
   35-50 min 20% solvent B
   50-62 min 35% solvent B
   62-70 min 40% solvent B
   70-80 min 60% solvent B
   80-85 min 100% solvent B

6) Solvent Flow rate: 0.5ml/min

7) Injection: 25 μ direct injection of a grape seed extract sample

8) Detector: Diode array detector with an analytical flow cell

9) Detection wavelength: 280 nm, bandwidth 16, scan 220-400 nm.

Size Exclusion Chromatography (SEC) - is a chromatographic method that is applied to determine molar mass distributions (MMD) of polymers. The separation is based upon differences in hydrodynamic volume of the molecules. Hydrodynamic volume is
dependent on the molar mass and the chemical composition/structure of the polymer molecules.

Calibration of the instrument with well-defined polystyrene samples allows for correlation of the molar masses of the standards, retention time/volume with the unknown polymers, and thus the approximation of the relative molar mass of unknown polymers.

The SEC was performed with the triple detection system consisting of: P580 isocratic pump (Separations); UV detector (Spectra physics); Viscosity combined refractive index detector Model 250 (Viscotek); right angle laser light scattering detector (Viscotek). The solvent used was DMF from Fluka. The concentration of the samples was 0.1 mg/ml in the solvent. DMF was modified with ammonium acetate (+0.5vol% aqueous 3M) and used as sample solvent and as eluent. The columns used were two PL Gel Mix B columns (with a guard column) at a temperature of 35°C. The temperature of the Model 250 DRI and viscosity detector was set at 40°C. The eluent flow was 1.0 ml/min. A polystyrene standard kit of Shodex was used for the calibration.

**Hydrodynamic Mechanical Light Scattering**

**Determination of Diameter of Molecules** - The hydrodynamic diameter of the molecule determined by dynamic mechanical light scattering in a 50% ethanol/water solution, assuming a spherical spatial distribution of the polymer chain in said solution wherein a hydrodynamic diameter of 5 nanometers
corresponds to a molecular weight of 10,000 MW. Under such conditions it is manifestly clear that adducts (polymers) of the catechin and epicatechin class of polyphenols of more than 7 units would have molecular weights of more than about 2000, and those having at least 10 units would have molecular weights of at least 3,000, the basic catechin or epicatechin subunit of each such polymer having a molecular weight of about 300 Daltons.

Molecular Weight Cut-Off Membranes - This method employs ultrafiltration membranes designed for separating proteins and other biomolecules by molecular weights. Amicon ultrafiltration membranes YM3, YM10 and YM30 were used which, respectively, will not pass molecules with a molecular weight higher than 3,000, 10,000 and 30,000 respectively. Figure 7 below is an overlay of three chromatograms obtained when the purified extract from crushed grape seeds was passed through the above mentioned three membranes. The extract dissolved in ethanol was first passed through the YM3 membrane and then consecutively through YM10 and YM30 membranes. The curves in Fig. 7 below show that even the filtrate of the described process contains a substantial portion polymeric material exhibiting the molecular weighs of polyproanthocyanidins of this invention (which are above 3000 Daltons in this case).
Figure 7(a): HPLC of Grape Seed Extract Filtrate: <3K molecular weight (A), >3K and <10K molecular weight (B), and >10K molecular weight (C).

Figure 7(b) obtained by redissolving Eluate II of the described process and passing the resulting solution through similar membranes, shows that Eluate II consists almost entirely of polymeric material whose effective molecular weight exceeds 10,000 Daltons and even some which effectively exceeds 100,000 Daltons as determined by this method. Similar experiments with Eluate II show that this material contains even higher apparent molecular weight equivalence.
Figure 7(b): HPLC of Grape Seed Extract Eluate II:
>100k equivalent molecular weight (A), >30k & <100k equivalent molecular weight (B), >10k and <30K equivalent molecular weight (C), and <10k equivalent molecular weight (D).
Bitterness is usually considered an undesirable characteristic and monomers and oligomers tend to contribute the undesirable bitterness characteristic disproportionately. It is therefore important that for uses of this invention the isolated material should be high in polymeric polyphenolics and contain minimal amounts of monomeric or oligomeric polyphenolics. The natural product isolate becomes useful, as described herein, if the ratio between the maximum of the polymeric distribution peak (which maximum occurs in the defined HPLC analysis between 35 and 70 minutes but is usually observed between 40 and 60 minutes), defined in the PPC composition definition (c), exceeds that present in the natural source material by at least 20\%, and preferably by more than 30\%.

As already noted, polymeric polyphenolic materials (polymeric polyphenol materials) may also be extracted from oak or other suitable sources employing the same extraction and isolation procedures described above for the extraction, isolation and purification of PPCs from grape seeds, demonstrating clearly that the effects of the invention are not limited to the polymeric materials extracted from grapes or grape seed. The source plant material may be treated by heat, exposure to oxidizing conditions or other methods prior to extraction to facilitate polymerization and creation of additional desirable
polymeric components of the invention. The characterization procedures will be the same as those already described and the desirable molecular weights and methods employed for determining them all are the same. The polymeric polyphenolic materials can result from the breakdown of lignin and similar compounds either before or during pretreatment and may thus be a complex mixture of similar materials produced by polymerization of several monomers or the breakdown or crosslinking induced by the treatment and/or the instability of some of the source monomers and oligomers.

The polymeric polyphenolics isolated from oak have a carbohydrate backbone with gallic acid moieties esterified to varying degrees. The three major subunits are gallic acid, carbohydrate and ellagic acid (a gallic acid dimer). These compounds can exist in very large polymers occurring naturally in raw oak. The compounds are extremely labile to heat and cannot be found in toasted oak products unless lightly toasted. They may condense to form polymers, some of which may be large and difficult to extract; or they may break down, or both effects may occur when heat is applied. Indeed, lignin itself, also present in oak and other woody plants, can break down on heating or with other oxidation processes to yield similar polymers with similar properties.
The extraction of oak employing prior art process steps in combination with the specific isolation and purification processes of this invention yields a complex mixture of largely polymeric materials as identified by the chromatographic, membrane, and light scattering methods mentioned above. Sensory panel testing of such materials in the same food products and basic tastes of these materials indicate that their effect is essentially the same as that of the PPCs from grape seeds discussed above, consequently such materials are an additional example of non-grape derived polymeric materials of the invention.

In the polymeric oak extracts there may be other compounds besides the specific PPCs and polymeric polyphenol materials, especially in toasted oak, which are at least partially responsible for these effects. Such other compounds may be derived from the breakdown of lignin, hemicellulose and other carbohydrate polymers during the toasting process. The phenyl propane subunits of lignin can be oxidized with heat to form a variety of compounds which include vanillin, vanillic acid, syringaldehyde and syringic acid to name a few. The hemicellulose and other carbohydrate polymers may form furfural, hydroxymethyl furfural and 5-methyl furfural. These compounds, as monomers, and many others are responsible for odor and flavor from toasted oak but may undergo further reactions, such as condensation, to form large molecules with the above
noted food-related properties. Such materials may change somewhat the intrinsic taste characteristics of the polymers into which they become incorporated, but as they are not known themselves to be flavor enhancers, they are not expected to materially affect the unusual enhancement properties of the phenolic based polymers identified as aspects of the invention.

Other similar polymeric phenolic based materials (for example lignin or ellagitannin based) will exhibit similar properties and behaviors as those described in the invention regardless of their source or precise method of preparation. However, the usefulness or practical commercial value of such materials will depend upon their stability under processing and use conditions. Hence, some of the specific materials of the invention (e.g. ellagitannins and particularly polymers derived from them) which are known to undergo hydrolysis and other degrading reactions under conditions of exposure to some foods may be less practical even though they manifest at least some of the essential properties of the invention described above.

The compositions of this invention, that is, the polymeric fraction extracted, isolated and purified as described above, have been discussed in terms of polymeric polyphenolic materials. Nevertheless it should be kept in mind that this polymeric material is extracted from a natural product that contains a
complex mixture of various materials. Therefore, even after isolation and purification, the resulting material will still contain a mixture of polymers and it is not intended to limit polymeric polyphenol materials and PPCs to pure polymeric polyphenolic materials. Thus whenever polymeric polyphenol materials or PPCs are mentioned above, it is intended that such terms encompass not only the polymeric polyphenolic materials but also other polymeric materials that may be present in the plant source and is extracted together with PPCs or that may be formed during various stages of processing, isolation or purification. The polymeric polyphenolics and other polymeric materials contained in the compositions of this invention may be defined in a number of ways mentioned below:

a) These polymers exhibit an apparent molecular weight greater than 3,000 Daltons and more preferably greater than 5,000 Daltons and even more preferably greater than 7,500 and most preferably greater than 10,000 Daltons. The useful PPC or other polymeric polyphenol material compositions on the dry weight basis, contain at least 40% by weight, and more preferably 60% by weight, and even more preferably 80% by weight, and further even 90% by weight, and up to 95% by weight and even more than 98% by weight, of higher molecular weight materials of more than 7 and preferably more than 10 repeat units of monomeric
proanthocyanidins or other phenolics. This desirable fraction is most conveniently determined by comparing the ratio of monomer, dimer and trimer peaks to the broad maximum of the polymeric distribution observed in the HPLC shown above. A key feature of the compositions of the invention is that they be enriched above the distribution of higher polymer indicated in the broad HPLC peak between 45 and 75 minutes so that the ratios of the polymer to the lower monomer and oligomer peaks are equal to or greater than those shown in Fig. 7(a) and (b).

b) These polymers, which possess the preferred higher molecular weights and number of repeat units, generally will exhibit a hydrodynamic diameter of at least 30 Å (3 nanometers) as determined by hydrodynamic mechanical light scattering as described above.

c) These polymers manifest hydrophobicity such that, under the conditions specified, in an HPLC column described above, they will elute from the specified hydrophobic interaction liquid chromatography column between about 45 and 75 minutes. The polymers are characterized by a broad maximum in this time range with no other important features, whereas the specific monomer, dimer and trimer peaks cited above are sharp and easily distinguished from the polymer peak under the stated conditions. Indeed, there is some overlap in position on the time axis
between the broad maximum and some of these peaks. This is because the adsorption of the material to the column is due to hydrophobic interaction and not directly to size or molecular weight. In fact the difference in the shapes of these peaks is another indication of the significant difference in the nature of the materials eluting in the regions where they overlap. Other elution conditions may be chosen to achieve higher or lower resolution for both the lower and higher molecular weight components. Under such conditions the relevant materials will elute at longer time periods even up to and beyond 4 hours for the polymer. The conditions specified herein above are chosen simply to permit a convenient standardized analysis for the sole purpose of indicating when a particular material may fall under the definition of the invention. Of particular importance are the differences and enrichments achieved at the highest end of the broad distribution (i.e. beyond 60 minutes), where the most hydrophobic fractions elute. The enhancement of intensity at a chosen time point in this range, relative to the intensity at the same time point in the crude extract or of an untreated food product such as grape juice or wine which may contain naturally some fractions of PPCs or other polymeric polyphenolic materials, is most reflective of the modified, improved and altered sensory characteristics of the materials of the invention.
d) These polymers (polymeric polyphenol materials such as PPCs) exhibit no perceivable bitterness in simple solutions as determined by standard sensory methodology at a concentration of at least 100 ppm and even at least 200 ppm and even at least 400 ppm and generally at least 500 ppm. As such, they are distinct and different from those MFCs and OPCs taught and described in the literature, since these exhibit bitterness at lower concentrations.

Although it is more practical and economical to extract, isolate, and/or otherwise separate these polymers from plant matter, it is also possible to prepare synthetically the monomeric compounds and then using known condensation methods to obtain synthetically the higher molecular weight, generally polymeric, materials that may be used as flavor and taste modifying additives according to this invention. Regardless of how produced or purified, the materials and compositions with the unique characteristics described herein are useful for one or another aspect of the invention.

Extensive work has been done on the use of phenolic and polyphenolic-based compounds to produce adhesives for the wood industry (see Plant Polyphenols by R. Hemingway and P. Laks, Plenum Press, 1992 ed., pp. 991 et seq. describing the work of A. Pizzi) wherein many routes for the condensation of these types of materials are described. Certain routes include the
use of a cross-linking agent, such as formaldehyde or acetaldehyde. Other routes may use a strong acid or a strong base to catalyze the condensation reactions to result in polymeric materials. Recently Pizzi reported the use of silica to effect polymerization of phenolic materials. Most presently available synthetic routes for the condensation of such materials are essentially uncontrolled and may produce a mixture of higher molecular weight materials. Pizzi's work may be applied in the synthesis of the polymeric compositions of this invention. Furthermore, it may be possible to obtain the higher molecular weight polyphenolic compositions of this invention by bioengineering. In addition it may be possible to obtain them from the oxidation or degradation of higher insoluble polymers and lignin based materials. Thus the specific manner in which the polymeric polyphenolic compositions of this invention are prepared is not of any consequence because the resulting materials, regardless of their source or how obtained, are effective in improving, modifying or enhancing the tastes and flavors of edible consumables.

Example 1.

Preparation of Polymeric Proanthocyanidin Extract from Vitis Vinifera

Vitis vinifera seed (4 Kg.) were ground and macerated for 5 hours with 8 liters of aqueous 80% ethanol at
room temperature. The solvent was drained from the seeds and the maceration repeated three times. The aqueous-ethanol extracts were combined, concentrated under vacuum to remove ethanol, lyophilized to remove water, and yielded crude grape seed extract.

Example 2.
Isolation of Grape Seed Extract

Crude grape seed extract (100g) was ground using a mortar and pestle, placed in a 1 L Erlenmeyer flask, and sonicated with 1 L of 95% ethanol for 30 minutes. The mixture was stirred, placed in a 40°C bath for 1 hour, and centrifuged at 10,000 rpm for 10 minutes to remove undissolved particulates. The supernatant was decanted into a 2L Erlenmeyer flask. Hexane (1000mL) was added with stirring to the decanted ethanolic solution, and the mixture permitted to stand for 20 minutes to effect complete precipitation. The Erlenmeyer now contained insoluble polymeric polyphenolic materials, an ethanol rich supernatant, and a hexane rich supernatant. Both supernatants, referred to as Crude Supernatants, were decanted from the insoluble polymeric polyphenolic materials. The polymeric polyphenolic materials were redissolved in 500 mL of 95% ethanol and reprecipitated by the addition of 500 mL of hexane. The polymeric polyphenolic materials were dissolved in 500 mL of 95% ethanol, concentrated in vacuo to remove ethanol, and
lyophilized to remove water, to yield Crude Precipitate.

All ethanol-hexane supernatants were combined and the hexane rich supernatant discarded. The combined ethanol rich supernatants were concentrated in vacuo and lyophilized to recover the polymeric material that remained in the ethanol solutions.

Example 3

Purification of Crude Grape Seed Extract

Sephadex LH-20 (125g), in an 800 mL beaker, was slurried with 500 mL of 95% ethanol, permitted to stand for 10 minutes, and loaded into a 50 mm diameter column. The headspace was pressurized with nitrogen to 5 psig and the solvent level brought down to about 1 cm above the top of the bed. All elutions of the column were conducted using 5 psig nitrogen pressure.

The column was eluted using 380 mL of 95% ethanol, 380 mL of 60% acetone-water, and finally 760 mL of 95% ethanol.

Crude Precipitate (25 g) was dissolved in 170 mL of 95% ethanol plus 1.5 mL of water by stirring for 30 minutes in a 40°C water bath. This solution of Crude Precipitate was applied to the top of the LH-20 column. Mixing and transfer apparatus was rinsed with 10 mL of 95% ethanol, and the rinse was also applied to the top of the column. The column was pressurized with nitrogen and the loading solution eluted until
the level of the loading solution dropped down to the top of the adsorbent bed. Additional solvents were then applied to the top of the column starting with a total of 1150 mL of 95% ethanol and ending with a total of 1150 mL of 60% acetone-water. Upon the changeover between 95% ethanol and 60% acetone-water care was exercised to minimize backmixing at the top of the column.

Effluent from the column from 0 to 144 mL was a forerun that was discarded; effluent from 144 mL to 404 mL was collected as Eluent I; effluent from 404 mL to 1490 mL was collected as a Middle Cut; effluent from 1490 mL to 1890 mL was collected as Eluent II; effluent from 1980 mL to 2480 mL was considered a post column wash and was discarded.

Eluent I and Eluent II were concentrated in-vacuo and to remove organic solvents and then lyophilized to remove residual water; yielding respectively, Eluate I and Eluate II. These materials were subjected to Size Exclusion Chromatography (SEC) employing the triple detection system described in the description of the SEC. The Molecular weights of Eluate I and Eluate II were determined to be as follows:

Eluate I: Mn × 20.3 kDa; Mw × 26.8 kDa
Eluate II: Mn × 15.8 kDa; Mw × 18.1 kDa.

The above described extraction, separation and purification methods can also be used for the preparation of PPCs from various plat sources other
than grape seeds to demonstrate a universal application of the extraction, fractionation and purification methods. The polymeric polyphenolic materials were extracted and purified from oak and the polymeric materials can also be extracted and purified from pine bark, cocoa powder, black tea and green tea according to the methods of Examples 1 to 3. The polymeric polyphenol materials from these natural sources have similar physical properties to the PPCs extracted from grape seeds and also exhibit similar effect on the modification of taste and flavor of various foods and beverages. The method of this invention is therefore useful to obtain purified polymeric polyphenol materials from any plant source that contains such polymeric polyphenolic materials.

One skilled in the art will understand that many variations and alterations are possible within the scope of the invention. Therefore, the invention in its broader aspects is not limited to the specific details and representative examples described herein. Accordingly, various modifications may be made without departing from the spirit or scope of the general inventive concept as defined by the appended claims and their equivalents.
WHAT IS CLAIMED IS:

1. A method of modifying, altering or enhancing the flavor, taste, mouthfeel or other sensory qualities of edible consumables by adding thereto an effective amount of a polymeric polyphenolic material.

2. A method of claim 1 wherein said edible consumables are selected from the group consisting of brown foods, dairy products, alcoholic beverages, artificially sweetened foods, dietetic foods, low-calorie foods, low-fat foods, alcoholic beverages and non-alcoholic beverages.

3. A method of claim 2 wherein said polymeric polyphenolic material is used in the amount of from 5 ppm to 1000 ppm on weight basis of the edible consumable.

4. A method of modifying, altering or enhancing the flavor, taste, mouthfeel or other sensory qualities of brown foods by adding thereto at least 1 ppm of a polymeric polyphenolic material.

5. A method of claim 4 wherein said polymeric material is employed in the concentration of from 5 ppm to 1000 ppm on weight basis.

6. A method of claim 3 wherein said polymeric polyphenolic is primarily polyproanthocyanidin.
7. A method of modifying, altering or enhancing the flavor, taste, mouthfeel or other sensory qualities of dairy products by adding thereto an effective amount of a polymeric polyphenolic material.

8. A method of claim 7 wherein said polymeric polyphenolic material is employed in the concentration of from 5 ppm to 1000 ppm on weight basis.

9. A method of claim 8 wherein said polymeric polyphenolic is primarily polyproanthocyanidin.

10. A method of modifying, altering or enhancing the flavor, taste, mouthfeel or other sensory qualities of alcoholic beverages by adding thereto an effective amount of a polymeric polyphenolic material.

11. A method of claim 10 wherein said polymeric polyphenolic material is employed in the concentration of from 1 ppm to 1000 ppm on weight basis.

12. A method of claim 11 wherein said polymeric polyphenolic is primarily polyproanthocyanidin.

13. A method of claim 12 wherein said alcoholic beverage is wine.

14. A method of claim 12 wherein said alcoholic beverage has an alcoholic content between 18% and 80%.

15. A method of claim 12 wherein said alcoholic beverage is a low alcohol content beverage containing an initial alcoholic content of from 0.10% to 10%.

16. A method of modifying, altering or enhancing the flavor, taste, mouthfeel or other sensory qualities of artificially sweetened foods by adding
thereto an effective amount of a polymeric polyphenolic material.

17. A method of claim 16 wherein said polymeric polyphenolic material is employed in the concentration of from 1 ppm to 5 ppm on weight basis.

18. A method of claim 17 wherein said polymeric polyphenolic is primarily polyproanthocyanidin.

19. A method of modifying, altering or enhancing the flavor, taste, mouthfeel or other sensory qualities of dietetic, low-fat or fat-free foods by adding thereto an effective amount of a polymeric polyphenolic material.

20. A method of claim 19 wherein said polymeric polyphenolic material is employed in the concentration of from 1 ppm to 500 ppm on weight basis.

21. A method of claim 20 wherein said polymeric polyphenolic is primarily polyproanthocyanidin.

22. A method of claim 19 whereby the sensory quality of creaminess is improved in said foods.

23. A method of improving the taste qualities of an edible consumable containing naturally a polyphenolic material by adding thereto from 5 to 1000 ppm on weight basis of a polymeric polyphenolic material.

24. A method of claim 23 whereby the sensory quality of a positive mouthfeel/fullness is improved in said consumable.
25. A method of claim 24 wherein said edible consumable is a wine.

26. A method of claim 25 wherein the polyphenolic material is polymeric proanthocyanidin.

27. A method of claim 1 whereby the sensory quality of salt substitutes is improved.

28. A method of claim 1 whereby the sensory quality of a flavor enhancer monosodium glutamate (MSG) is improved.

29. A method of improving the taste of an artificial sweetener by adding therein 1 ppm to 400 ppm on weight basis of a polymeric polyphenolic material.

30. A method of claim 29 wherein the polymeric polyphenolic material is primarily a polymeric proanthocyanidin.

31. A method of claim 29 wherein the artificial sweetener is saccharin.

32. A composition of matter extracted from plant matter containing at least about 40 weight percent of polymeric materials.

33. A composition of claim 32 containing at least 50 weight percent of polymeric materials.

34. A composition of claim 33 wherein said plant matter is grape seeds.

35. A composition of claim 34 wherein said polymeric material is primarily polymeric proanthocyanidin.
36. A composition of claim 34 containing at least 80 weight percent of polymeric materials.

37. A composition of claim 34 containing at least 90 weight percent of polymeric materials.

38. A composition of matter containing
   a) at least 50 percent by weight of polymeric material of claim 33 and
   b) up to 50 percent by weight of low molecular weight plant extract comprising up to about 2.5 percent by weight of primarily monomeric proanthocyanidins, and 10-35 percent by weight of oligomeric proanthocyanidins and the balance of impurities.

39. A composition of matter of claims 38 wherein both said low molecular weight and said polymeric materials are extracted from one or more of berry, seed, skin, or stem of a plant.

40. A method of isolating primarily polymeric materials from a plant extract, said method comprising
   a) dissolving the extract in a solvent;
   b) adding a precipitant to said solvent to form a precipitate;
   c) isolating the precipitated material;
   d) dissolving the precipitate in a solvent;
   e) mixing the solution of the precipitate with an adsorbent;
f) washing said absorbent containing the polymeric materials adsorbed thereto with a solvent that disrupts the adsorption effect between the absorbent and the polymeric materials; and

g) recovering the resulting polymeric materials.

41. A method of claim 40 wherein said extract is from grape seeds.

42. A method of isolating polymeric material from an extract in a solvent from plant matter, said method comprising

a) dissolving the extract and

b) passing the solution through an ultrafiltration membrane such that a substantial portion of polymeric particles having at least ten repeat units will not pass through said membrane.

43. A method of claim 42 wherein said plant matter is grape seeds.

44. A method of isolating polymeric materials from an extract from plant matter, said method comprising extracting said polymeric materials with a two phase solvent extraction.

45. A method of modifying, altering or enhancing the flavor, taste, mouthfeel or other sensory qualities of edible consumables by adding thereto an effective amount of a composition of claim 32, 33, 35, 36, 37, 38 or 39.
46. A method of claim 45 wherein said edible consumables are selected from the group consisting of brown foods, dairy products, alcoholic beverages, artificially sweetened foods, dietetic foods, low-calorie foods, low-fat foods, alcoholic beverages and non-alcoholic beverages.

47. A method of claim 46 wherein said composition is added in the amount of from 5 ppm to 1000 ppm on weight basis of the edible consumable.

48. A method of modifying, altering or enhancing the flavor, taste, mouthfeel or other sensory qualities of edible consumables by adding thereto an effective amount of a composition obtained from the method of claim 40, 41, 42, 43 or 44.

49. A method of claim 48 wherein said edible consumables are selected from the group consisting of brown foods, dairy products, alcoholic beverages, artificially sweetened foods, dietetic foods, low calorie foods, low-fat foods, alcoholic beverages, and non-alcoholic beverages.

50. A method of claim 49 wherein said composition is added in the amount of from 5 ppm to 1000 ppm on weight basis of the edible consumable.

51. A method of claim 49 wherein said composition is added in an amount that is below its detection threshold in a simple solution.
52. A method of claim 49 wherein said composition is added in the amount of at least 1 ppm on weight basis of the edible consumable.