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<p>(54) Title: FOOD COMPOSITIONS FORTIFIED WITH ANTI-OXIDANTS</p> <p>(57) Abstract</p> <p>Food composition containing 20-100 wt.% of an aqueous phase characterized by an enhanced content of tyrosol and hydroxytyrosol in aqueous phase being at least 15 ppm. The aqueous phase preferably results from exposing olive oil that contains polyphenols under hydrolytic conditions to an aqueous phase, so that lipophilic phenolic compounds will hydrolyse and will migrate as hydrophilic polyphenols to the aqueous phase. The invention is suited for enhancing the nutritional value particularly of spreads, processed tomato products and dressings.</p>		

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10 **FOOD COMPOSITIONS FORTIFIED WITH ANTI-OXIDANTS**

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The present invention deals with processed food  
15 compositions, which contain an enhanced content of anti-oxidants, particularly of phenolic compounds which originate from olive oil. Such compositions fit in a healthy diet.

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**BACKGROUND OF THE INVENTION**

The incidence of cardiovascular diseases in a population is correlated with the occurrence of a high blood cholesterol  
25 content. The blood cholesterol level has been found to be decreased by a diet, which contains specific food components. For example, it is recommended to eat fats with a high content of unsaturated fatty acids.

It is known further that particularly diets which contain  
30 olive oil are healthy, because olive oil consumption contributes to a good balance of HDL cholesterol and LDL

cholesterol in the blood. Recently it has been found that some minor fat components particularly the anti-oxidants, including polyphenols from fat, positively interfere with the body's cardiovascular system, particularly because they  
5 are believed to help control oxidation of blood cholesterol. Non-refined olive oil has a high content of phenolic compounds which often are denoted as phenolics or as polyphenols.

10 Copending WO 99/32589 describes a practical application of said finding. The invention relates to spreads which contain olive oil as well as phenolic compounds. Traditionally for spread preparation a fully refined olive oil is employed, with the effect that together with the  
15 impurities also the beneficial phenolic compounds are removed. Said patent application describes a mild refining process which delivers a purified oil from which undesired olive oil odour and most of the free fatty acids have been removed, but which still contains a considerable amount of  
20 healthy phenolic compounds.

The phenolics derived from olive oil form a group of chemical compounds, some of which have a relatively high oil solubility, the lipophilic phenolic compounds, while  
25 others are more soluble in water, the hydrophilic phenolic compounds. When olive oil is contacted with a water phase, e.g. during a water washing step, a partitioning of phenolic compounds occurs. A great part of the hydrophilic phenolic compounds easily migrate to the water phase, while the

major part of the lipophilic phenolic compounds stay in the oil phase.

At least a part of the bitter taste of olive oil is ascribed to phenolic compounds, mainly to the lipophilic phenolic compounds.

In the co-pending patent applications EP 849353 and EP 933419 olive oil processes are described, which aim at debittering the oil by removing and/or hydrolysing the lipophilic phenolic compounds in olive oil. By hydrolysis the bitter lipophilic phenolic compounds are converted into less bitter and more water soluble phenolic compounds. Since these migrate to the water phase of the olive oil/water mixture, they are removed when the separated water phase is discarded.

WO 97/06697 teaches a healthy diet consisting of food products which have been fortified with high amounts of anti-oxidants, including phenolic compounds. The only phenolic compounds disclosed are catechins which are the water-soluble polyphenols originating from tea. The hydrophilic phenolic compounds used in the present invention originate from olives, they have a different chemical identity and are believed to play a different nutritional and metabolic role. The hydrophilic phenolic compounds from olives consist mainly of tyrosol and hydroxytyrosol. For food fortification tea polyphenols are less attractive, because tea is an expensive source material.

Non-prepublished patent application WO 99/30724 has disclosed generally a mixture of hydrophilic polyphenols of different origin to be used in a diet which aims to protect against cardiovascular afflictions.

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Although since long food compositions have been prepared with unrefined virgin olive oil, the presence in such foods of hydrophilic phenolic compounds from olives have remained long unnoticed. In the aqueous phase of food compositions  
10 hydrophilic phenolic compounds can be found, but only in relatively low amounts. When both a fat phase and an aqueous phase are present in said food composition, under the conditions under which the food is prepared and stored the content of hydrophilic phenolics might increase  
15 slightly. They are formed by hydrolysis of lipophilic phenolic compounds, particularly at the interface of oil and water phases. The level of hydrophilic phenolics depends on the type of food.

20 The present invention particularly deals with salad dressings, emulsion spreads and processed tomato compositions.

The salad dressings mentioned in this specification are the well known sour tasting food compositions containing a  
25 water phase of at least 20 wt.% and having a pourable or a spoonable consistency. Salad dressings often contain a dispersed fat phase, even up to about 80 wt.% (mayonnaise). When dressings are prepared with much virgin, unrefined olive oil, they contain relatively much water soluble olive  
30 oil phenolic compounds. However, the content of tyrosol and

hydroxytyrosol present in water phase is always less than 100 ppm.

The water and oil emulsion spreads are food products which have a plastic consistency and often consist of a W/O-emulsion containing dispersed fat even up to 80 wt.%. The processed tomato products include sauces, like ketchup, which contain no or only a small amount of dispersed fat. For spreads and processed tomato products unrefined olive oil is a rare and minor ingredient. Up to now the content of tyrosol and hydroxytyrosol in the water phase of these products has never surpassed 15 ppm.

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#### **SUMMARY OF THE INVENTION**

The present invention is based on the finding that hydrophilic phenolic compounds which originate from olive oil are a useful food ingredient, because they have a nutritional functionality which is comparable with and supplementary to the functionality of the lipophilic phenolic compounds from olive oil. The present invention comprises use of hydrophilic phenolic compounds for the preparation of a food composition with an increased nutritional value.

The food composition according to the invention comprises 20 - 100 wt.% of an aqueous phase which aqueous phase contains hydrophilic olive polyphenols in concentrations which, in aqueous phase, are at least 15 ppm.

The hydrophilic olive polyphenols are tyrosol and hydroxytyrosol and the food composition preferably is a processed food composition chosen from the group consisting of water and oil emulsion spreads, processed tomato products and salad dressings, the concentration of tyrosol and hydroxytyrosol taken together in aqueous phase is at least 100 ppm for salad dressings and at least 15 ppm for water and oil emulsion spreads and for processed tomato products.

10

Food compositions according to the invention can be prepared by the steps of selecting the usual ingredients and processing these in the usual way, with the proviso that at least one of the ingredients must consist of or contain tyrosol and hydroxytyrosol in such concentration that in the final composition the concentration of tyrosol and hydroxytyrosol taken together has a value as specified above.

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#### **DETAILS OF THE INVENTION**

In olive oil derived food compositions often hydrophilic phenolic compounds are present. Tyrosol and hydroxytyrosol are the major representatives. After an aqueous phase has exchanged polyphenols with unrefined olive oil, at least one and mostly both of these two polyphenols are present. Hydrophilic olive derived phenolic compounds are present as such in the olive fruit. They may be formed also after



processing of the olive fruits by hydrolysis of lipophilic phenolic compounds such as oleuropein and aglycon.

For the preparation of the invented food compositions 5 hydrophilic phenolic compounds are used suitably in the form of a ready aqueous solution. A suitable and easily available water phase which contains an high level of hydrophilic phenolic compounds is the aqueous phase resulting from separating an O/W-emulsion that comprises an 10 oil consisting wholly or partially of unrefined olive oil and water.

Such water phase is e.g. the aqueous liquid which remains after debittering olive oil by hydrolysis of its bitter ingredients according to the inventions referred to earlier 15 in this specification. Before the invention found an application for those liquids, they were of no use and were discarded as waste.

Another aqueous phase containing hydrophilic phenolic 20 compounds results from the common production process of olive oil. The aqueous phase collected after the steps of malaxation of olive fruits and subsequent olive oil separation was also considered waste material, but it has appeared to be a rich source of phenolic compounds. These 25 can be harvested from the waste water or the water can be used as such, if necessary after purification.

A feasible and efficient alternative for the above aqueous phases is adding tyrosol and hydroxytyrosol as such, 30 particularly as a more or less purified isolate, e.g. in

the form of a dry preparation, such as a powder whether or not in admixture with other hydrophilic phenolic compounds.

The invention also comprises a process in which the aqueous phase does not contain either tyrosol or hydroxytyrosol as such, but a precursor such as aglycon from which tyrosol or hydroxytyrosol is formed spontaneously by hydrolysis during food preparation or shortly thereafter.

10 Water and oil emulsion spreads which contain olive oil are known. These contain either unrefined or partially refined olive oil. The aqueous phase of such spreads contains a small amount, but less than 10 ppm of tyrosol and hydroxytyrosol, resulting from migration by diffusion from  
15 the fat phase into the aqueous phase.

For the manufacture of a spread according to the invention any usual spread manufacturing technology can be used.

Preferably, the tyrosol and hydroxytyrosol are dissolved in  
20 the aqueous phase or an aqueous phase is used which contains those phenolics and, optionally, other phenolics. Any fat phase usual for spread preparation may be employed.

A particular embodiment provides "in-situ" fortification of  
25 the aqueous phase with tyrosol and hydroxytyrosol. The process consists of choosing a non-refined olive oil, optionally mixing it with a margarine fat and emulsifying the fat phase with an aqueous phase with the relatively high pH value of 5.5 or more. Under these conditions

hydrolysis of lipophilic olive phenolics occurs at the interphase of fat phase and aqueous phase.

The crude emulsion is exposed to the hydrolyzing conditions for such time that a desired amount of hydrophilic phenolic  
5 compounds are formed. The process can be stopped, e.g. by lowering the pH to 4.5 - 5 which is a common value for the aqueous phase of spreads. Subsequently, any remaining spread ingredients are added to the crude pre-emulsion. It is subjected to regular spread processing and a product is  
10 obtained with an enhanced content of tyrosol and hydroxytyrosol in the aqueous phase.

When in an emulsion product like spread after manufacture the hydrolysing conditions at the fat and water interface  
15 continue to exist and the fat phase still contains unhydrolyzed phenolics, the fortification of the water phase with hydrolyzed phenolic compounds originating from the fat phase may proceed even during storage of the product.

20

Both lipophilic and hydrophilic phenolic compounds are useful food supplements, but never attention was given to a proper balance of both in food products. The present invention enables the beneficial increase of the ratio of  
25 hydrophilic phenolic compounds and lipophilic phenolic compounds. It is the merit of the present invention that it provides the specific, above-mentioned food compositions which contain enhanced levels of the potent hydrophilic phenolic compounds tyrosol and hydroxytyrosol.

30

The invention is illustrated by the following examples:

#### GENERAL

##### 5                   QUANTITATIVE DETERMINATION OF PHENOLICS                     PRESENT IN A WATER PHASE

The analytical separations were performed on a Waters 600 S liquid chromatograph equipped with a Waters 616 pump and a  
10 Waters 490 UV multiwavelength detector. Injection of the water samples was carried out by a 10 µl Rheodyne sample loop. A Chrompack 250 mm x 4.6 mm x 1.4 inch Intersil 15 ODS column was applied using a gradient at a flow rate of 1 ml/min. The elution system consisted of a solvent A (2%  
15 acetic acid in water) and solvent B (methanol). Gradient: 0-20 min., A/B 85/15 %; 20-50 min., increase 15-75% B in A; 50-55 min., A/B 25/75, 55-56 min., increase 75-100% B in A; 56-65 min., 100% B. UV was measured at  $\lambda = 280$  nm (for quantification). The column efficiency is shown with a  
20 standard mixture of polar polyphenols.

##### PREPARATION OF A WATER PHASE CONTAINING TYROSOL AND                     HYDROXYTYROSOL

25  
Two volumes of extra virgin olive oil and one volume of regular tap water obtained from the local tap water supply (city of Vlaardingen, pH 7.5), were vigorously stirred under reduced pressure at a temperature of 22°C using a  
30 mixing device which dissipated about 4 kJ/s of energy per ton of oil. Stirring was discontinued after thirty minutes

and oil and water phases were allowed to separate. The aqueous phase, denoted as "olive oil water", containing tyrosol and hydroxytyrosol, was used as the aqueous phase in the following examples.

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**EXAMPLE 1**

## SPREAD PREPARATION

10

**FAT BLEND**

15%           interesterified mixture of  
                   65 wt. parts of palm oil stearin and  
                   35 wt. parts of palm kernel oil

15 85%       refined sunflower seed oil

wt. %

**FAT PHASE****60**

above fat blend           59.68

20 Hymono 8903<sup>TM</sup>           0.22

beta-carotene<sup>1</sup>           0.10

**WATER PHASE****40**

salt                       0.30

25 K-sorbate               0.10

"olive oil water"       26.40

water                     13.20

lactic acid               until pH = 4.5 - 4.7

<sup>1</sup> beta-carotene in the form of a solution of 0.4 wt.%  
beta-carotene in sunflower seed oil.

The fat phase and the water phase were mixed. The obtained  
5 premix was processed employing a laboratory scale Votator™  
using an A-A-C sequence.

Throughput	: 4.5 - 5.0 kg/hr
First A-unit	: 800 rpm, exit temperature 8°C
Second A-unit	: 800 rpm, exit temperature 6°C
10 C-unit (50 ml)	: 250 rpm, exit temperature 12°C

The obtained spread was analyzed on phenolics content by  
the method described above. The concentration of tyrosol  
and hydroxytyrosol taken together in water phase was 48  
15 ppm.

## EXAMPLE 2

20 SPREAD PREPARATION

### FAT BLEND

15%	interesterified mixture of
	65 wt. parts of palm oil stearin and
25	35 wt. parts of palm kernel oil
85%	extra virgin olive oil

wt. %

### FAT PHASE

30	above fat blend	60
		59.68

13

Hymono 8903™	0.22
beta-carotene <sup>1</sup>	0.10

<b>WATER PHASE</b>	<b>40</b>
5 salt	0.30
K-sorbate	0.10
water	39.60
lactic acid	until pH = 4.5 - 4.7

10 <sup>1</sup> beta-carotene in the form of a solution of 0.4 wt.%  
beta-carotene in sunflower seed oil.

Before the premix was prepared, olive oil and water were mixed at 25°C for 30 minutes. After 30 minutes the aglycon  
15 polyphenols had been hydrolyzed and the hydrolysis products had migrated to the aqueous phase. The temperature was raised to 55°C. First the hardstock fat was added and then the other ingredients. The mixture was processed employing a laboratory scale Votator™ using an A-A-C sequence.

20 Throughput	: 4.5 - 5.0 kg/hr
First A-unit	: 800 rpm, exit temperature 8°C
Second A-unit	: 800 rpm, exit temperature 6°C
C-unit (50 ml)	: 250 rpm, exit temperature 12°C

25 The obtained spread was analyzed on phenolics content by the method described above. The concentration of tyrosol and hydroxytyrosol together in water phase was 47.5 ppm.

#### COMPARISON EXAMPLE 2

30

Example 2 was repeated but the water phase and the fat phase were prepared separately and only then mixed as usual for spreads preparation. After processing the obtained spread was analyzed on phenolics content by the method 5 described above. The concentration of tyrosol and hydroxytyrosol together in water phase was 38.6 ppm.



**EXAMPLE 3**

## PREPARATION OF A VINAIGRETTE

5 A vinaigrette was prepared using the following ingredients

	wt. %
Sugar	7.00
Salt	2.10
Keltrol TM	0.35
Alcohol vinegar (12% Hac)	4.20
Spice vinegar (10% HAC)	6.00
Dried onion pieces (Dehyfood TM)	0.50
Dried parsley extra fine (Dehyfood TM)	0.08
Grinded carrot (Preserven TM)	0.08
Sorbic acid	0.10
Trisodium citrate.2 aq	0.35
"Olive oil water"	39.62
Tap water	39.62
	100.00
PH	3.74

All ingredients except the vinegars and the olive oil water  
 10 (obtained by the procedure described above) were mixed and  
 heated at 85°C for 5 minutes. Then the vinegars and the  
 olive oil water were admixed resulting in a vinaigrette

which was analyzed on phenolics content by the method described above. The concentration of tyrosol and hydroxytyrosol together in water phase was 31.3 ppm.

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**EXAMPLE 4**

## PREPARATION OF A TOMATO SAUCE

A tomato sauce was prepared using the following 10 ingredients

	wt. %
Salt	0.5
Tomato paste	27.58
"Olive oil water"	35.96
Tap water	35.96
	100.00
PH	4.18

All ingredients except the olive oil water (obtained by the procedure described above) were mixed. Then the olive oil 15 water was admixed resulting in a tomato paste which was analyzed on phenolics content by the method described above. The concentration of tyrosol and hydroxytyrosol taken together in water phase was 34.5 ppm.

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**Claims**

1. A food composition of which 20 - 100 wt.% consists of an aqueous phase which aqueous phase contains hydrophilic olive polyphenols in a concentration in aqueous phase of at least 15 ppm.
2. A food composition according to claim 1, characterised in that the hydrophilic olive polyphenols are tyrosol and hydroxytyrosol, which food composition is a processed food composition chosen from the group consisting of water and oil emulsion spreads, processed tomato products and salad dressings, the concentration of tyrosol and hydroxytyrosol taken together in aqueous phase is at least 100 ppm for salad dressings and at least 15 ppm for water and oil emulsion spreads and for processed tomato products.
3. A food composition according to claims 1 or 2, characterized in that in the aqueous phase of a water and oil emulsion spread or a processed tomato product the concentration of tyrosol and hydroxytyrosol taken together in aqueous phase is at least 30 ppm, preferably at least 50 ppm, more preferably at least 100 ppm, still more preferably at least 300 ppm, still more preferably at least 500 ppm.
4. A food composition according to claims 1 or 2, characterized in that in the aqueous phase of a salad

dressing the concentration of tyrosol and hydroxytyrosol together in aqueous phase is at least 125 ppm, preferably at least 200 ppm, more preferably at least 500 ppm.

5. A food composition according to anyone of the previous claims, characterized in that a fat phase comprising olive oil, preferably unrefined olive oil, is present.
6. A food composition according to anyone of the previous claims, characterized in that the upper limit of the concentration of tyrosol and hydroxytyrosol is either the maximum solubility in water of 4°C or 20 wt.%, whichever value is the lowest.
7. A process for the preparation of a food composition according to the previous claims comprising the selection of the ingredients usual for such composition, including an aqueous phase, and the processing of those ingredients in the usual way, characterized in that one or more ingredients consist of or contain tyrosol and hydroxytyrosol or their precursors oleuropein or aglycon in such concentration that in the ready composition the concentration of tyrosol and hydroxytyrosol taken together has a value as specified in the previous claims.
8. A process according to claim 7, where an aqueous phase or a part of the aqueous phase is used which

results from separating an emulsion comprising unrefined olive oil and water.