NOVEL FUNCTIONAL FOOD WITH ANTIOXIDANT ACTIVITY

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IT IS GREAT TO LIVE LONGER IF YOU STAY HEALTHY AND YOUNG.

HARRY EMERSON FOSDICK
Many factors affect health and longevity of modern man. These include environment, social relations and nutrition. According to dr Serbel healthy living depends primarily on nutrition, rather than the other factors.

The power of food and its use to treat various diseases is well known since ancient times (460–370 b.c.).
LET YOUR FOOD BE YOUR MEDICINE AND YOUR MEDICINE - YOUR FOOD.

HIPOCRATESS
Time passed and ancient advices had been forgotten. It was assumed that healthy nutrition is a matter of energy and nutrient balance, and food should only provide the necessary nutrients – proteins, carbohydrates and fats for the proper performance of metabolic processes.

The concept of nutrition changed after the finding that many of the major diseases – atherosclerosis, stroke, asthma, diabetes type 2, hypertension and many forms of cancer are influenced by nutrition.
For the first time in the 80’s of the last century, Japanese began to work on problems related to healthy nutrition and its effects on various physiological systems in human body. They began to investigate the role of food to prevent diseases and improve the functioning of all systems, and introduced the term "functional foods."
Which foods are functional?

A food can be called **functional** if it positively influences one or more functions of human body, related to improved health or reduced risk of diseases.
These are foods that have a particular impact on the human body. Furthermore, **functional foods** must:

- Have a regulating effect on physiological systems.

- Reduce the risk of diseases – cardiovascular, liver, osteoporosis, gastrointestinal, non–insulin diabetes, etc.

- Help the body cope with the disease that has already occurred.

- Have a protective role against chemical toxicity and balancing effect the intestinal microflora.

- Improve lipid metabolism, activate the immune system, protect against oxidative stress, etc.
Biologically Active Substances of Functional Foods

- Dietary fibre (mainly polysaccharides and oligosaccharides)
- Flavonoids (anthocyanins, flavonols, catechins, etc.);
- Isoprenoids;
- Aminoacids;
- Vitamins;
- Glucosinolates;
- Saponins;
- Peptides and proteins;
- Lactic acid bacteria;
- Poly-unsaturated fatty acids;
- Phytohormones;
- Minerals;
- Terpenes.
In the recent years, foods rich in polyphenolic compounds and particularly in flavonoids gained much attention, since they are characterized by strong antioxidant properties. Rich source of these compounds are fruits (mainly berries), vegetables and herbs. A significant amount of scientific data evidences that increased consumption of these foods reduces the risk of many degenerative diseases such as cancer and cardiovascular diseases.
One of the main tasks and applied activities of the Laboratory of Biologically Active Substances in Plovdiv is to examine the antioxidant activity of fruits, vegetables and herbs grown in Bulgaria and to develop technologies for food supplements, functional and medical foods, rich in natural antioxidants and other bioactive components.
Fig. 1. ORAC antioxidant activity of fruits

- Honeydew melon: 2,3
- Watermelon: 3,8
- Pumpkin: 4,9
- Peach: 6,2
- White grapes: 6,3
- Apricot: 7,2
- Plum: 10,8
- Fig: 13,6
- Apple: 13,8
- Pomegranate: 19,7
- Cherry: 25,8
- Red grapes: 26,8
- Raspberry: 38,9
- Strawberry: 47,2
- Cornel cherry: 49,0
- Sour cherry: 58,6
- Cranberry: 70,0
- Blackberry: 74,2
- Blackthorn: 79,1
- Black currant: 96,0
- Blueberry: 98,8
- Chokeberry: 110,3
- Hawthorn: 153,6
- Brier: 201,1
- Elderberry: 205,4
Fig. 2. ORAC antioxidant activity of vegetables
Fig. 3. ORAC antioxidant activity of herbs
<table>
<thead>
<tr>
<th>Functional drinks</th>
<th>Polyphenols mg/l</th>
<th>ORAC μmol TE/l</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aronia juice with fructose added</td>
<td>2934</td>
<td>42188</td>
</tr>
<tr>
<td>Aronia nectar no sugar added</td>
<td>1571</td>
<td>24253</td>
</tr>
<tr>
<td>Aronia nectar with sugar added</td>
<td>1378</td>
<td>24039</td>
</tr>
<tr>
<td>Blackberry nectar no sugar added</td>
<td>1280</td>
<td>21470</td>
</tr>
<tr>
<td>Blackberry with aronia with sugar</td>
<td>1537</td>
<td>21090</td>
</tr>
<tr>
<td>Black currant nectar no sugar added</td>
<td>1119</td>
<td>19229</td>
</tr>
<tr>
<td>Strawberry nectar no sugar added</td>
<td>1030</td>
<td>18523</td>
</tr>
<tr>
<td>Strawberry with aronia with sugar</td>
<td>1018</td>
<td>13109</td>
</tr>
<tr>
<td>Raspberry with aronia with sugar</td>
<td>821</td>
<td>8155</td>
</tr>
<tr>
<td>Raspberry nectar no sugar added</td>
<td>522</td>
<td>8026</td>
</tr>
<tr>
<td>Orange with aronia with sugar</td>
<td>493</td>
<td>7286</td>
</tr>
</tbody>
</table>
The obtained results led to the opportunity to create database tables for the antioxidant activity of Bulgarian fruits, vegetables and herbs, which could be used in medical practice.
Based on literature data for the biological activity of vegetables and results obtained by us for antioxidant activity, we developed new laboratory technologies for vegetable products with incorporated spices and herbs (Table 2).
Table 2. *Functional foods based on vegetables, rich in biologically active substances obtained in LBAS in Plovdiv*

<table>
<thead>
<tr>
<th>Functional Food</th>
<th>Used vegetables and spices</th>
<th>Potential health benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>puree from leek, red beet, carrot and apple</em></td>
<td>red beet, carrot, leek apple, garlic</td>
<td>cancer prevention; improvement of post–hospital conditions.</td>
</tr>
<tr>
<td><em>puree from leek and red beet</em></td>
<td>leek, red beet</td>
<td>supply the body with fiber, promote fat metabolism, and regulate liver function. raw materials have pronounced antioxidant activity.</td>
</tr>
<tr>
<td><em>puree from zucchini, leeks and potatoes</em></td>
<td>leek, zucchini, potatoes, garlic, dill</td>
<td>suitable for patients with diabetes and hypertension.</td>
</tr>
<tr>
<td><em>vegetable mix of spinach and leeks</em></td>
<td>spinach, leek, spearmint and black pepper</td>
<td>suitable for diabetics. possess antiseptic and antibacterial activity</td>
</tr>
<tr>
<td><em>vegetable mix of green beans and red beet</em></td>
<td>green beans, red beet, garlic, parsley</td>
<td>part of the food regimen of patients with metabolic diseases, and particularly diabetes, cardiovascular and cancer.</td>
</tr>
<tr>
<td><em>vegetable mix</em></td>
<td>red pepper, carrot, zucchini, leek, mushrooms, dill, thyme, garlic, shallots</td>
<td>provides the body with vitamins and antioxidants; helps to activate the immune system.</td>
</tr>
</tbody>
</table>


### Table 3. *Biologically active substances in some medicinal plants*

<table>
<thead>
<tr>
<th>Common name</th>
<th>Latin name</th>
<th>Active compounds</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. John’s wort</td>
<td><em>Hypericum perforatum</em> L.</td>
<td>Rutin, Carotenoids, Quercetin, Sesquiterpenes, Hypericin</td>
</tr>
<tr>
<td>Hawthorn</td>
<td><em>Crataegus monogyna</em> L.</td>
<td>Flavone glucoside, Vitexin, Quercetin, Tartaric, malic, succinic acids, Pectic polysaccharides, Starch</td>
</tr>
<tr>
<td>Thyme</td>
<td><em>Thymus vulgaris</em> L.</td>
<td>Thymol; Carvacrol, Sesquiterpenes Rosmarinic acid</td>
</tr>
<tr>
<td>Chamomile</td>
<td><em>Marticaria chamomilla</em> L.</td>
<td>Sesquiterpenes, Paraffin, Bisabolol; Apigenin–7–O–glucoside, Choline, Mucus polysaccharides</td>
</tr>
<tr>
<td>Sage</td>
<td><em>Salvia officinalis</em> L.</td>
<td>Vitamins C, B–complex, PP, Apigenin; Luteolin; Saponins, Carotenoids, Phenolic acids, α– and β–pinene, Camphor</td>
</tr>
</tbody>
</table>
To obtain these herbal products, two approaches were used:

– Development of technology for herbal teas with high antioxidant activity for the prevention of various diseases. Altogether, six samples were prepared.

– Chamomile (two versions), lemon balm, thyme, sage, and hawthorn (leaves and blossom).

– Development of technologies for combined herbal teas, which are applied in the treatment of certain diseases.
Table 4. *Antioxidant activity and polyphenol content of instant herbal teas*

<table>
<thead>
<tr>
<th>Instant herbal tea</th>
<th>ORAC, μmolTE/g</th>
<th>Polyphenol content, mg/100g</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chamomile version 1</strong></td>
<td>434,4</td>
<td>1475,2</td>
</tr>
<tr>
<td><strong>Chamomile version 2</strong></td>
<td>329,7</td>
<td>1090,3</td>
</tr>
<tr>
<td><strong>Lemon balm</strong></td>
<td>1410,7</td>
<td>7396,3</td>
</tr>
<tr>
<td><strong>Hawthorn (leaves and blossoms)</strong></td>
<td>722,8</td>
<td>2731,7</td>
</tr>
<tr>
<td><strong>Sage</strong></td>
<td>911,6</td>
<td>3896,8</td>
</tr>
<tr>
<td><strong>Thyme</strong></td>
<td>914,6</td>
<td>3969,7</td>
</tr>
<tr>
<td><strong>Combined herbal tea 1</strong></td>
<td>406,1</td>
<td>2427,8</td>
</tr>
<tr>
<td><strong>Combined herbal tea 2</strong></td>
<td>311,0</td>
<td>1845,6</td>
</tr>
</tbody>
</table>
A very important moment in the development of functional foods is to study their impact on human organism.

We have provided the produced functional foods (mainly berry juices and nectars) for clinical trials to various hospitals in the country.
In the department of Endocrinology at Medical University–Plovdiv was found that:

- The administration of 200 ml dietetic aronia nectar (no sugar added) reduces blood sugar levels by two points. Lowering of cholesterol and triglycerides was recorded as well.


- 10-day administration of dietetic aronia juice resulted in statistically significant increase in antioxidant capacity of blood plasma in healthy subjects.


- Administration of aronia juice leaded to improved blood glucose levels, and particularly serum lipids – cholesterol and triglycerides in patients with diabetes mellitus.

In the department of Cardiology at Medical University – Plovdiv was found that two–month administration of aronia juice to patients with asymptomatic mild hypercholesterolemia resulted in statistically significant reduction in low–density cholesterol, increasing high–density cholesterol and apolipoprotein–A1.


In Cancer clinic – Plovdiv was investigated the influence of the intake of aronia nectar with pectin added on cancer patients undergoing chemotherapy and radiotherapy. It was found that the quality of life of the patients improved during the therapy and went without complications with good blood and immunological parameters.


In *the specialized hospital for active treatment in oncology, Sofia*, prof. Balansky found that:

– Aronia nectar enriched in pectin has protective effect in models of intestinal carcinogenesis induced by 1,2-dimethylhydrazide. The effect was expressed mainly in the delay of tumor promotion, increased proportion of benign tumors, and reduction in the amount of induced neoplastic lesions.


– In mouse exposed to cigarette smoke, administration of aronia and strawberry nectars for 4 months inhibited the cigarette smoke-related, cytogenetical damage, liver degeneration, pulmonary emphysema, lung adenomas, and body weight loss. The protective effects were more pronounced in female mice in comparison to male animals.

**Functional foods** are an important direction in the science of human nutrition. This kind of foods occupies a significant volume of food production in the world, which is increasing every year.

**Functional foods** are a challenge to scientists from different disciplines – chemists, pharmacists, technologists, physicians and others. United efforts to work in this area will meet the increasingly growing interest in functional foods, because they really enhance the quality of life, reduce the risk of disease and slow aging.
Thanks for your attention!