BaSeFood
(G.A. n°227118)
Sustainable exploitation of bioactive components from the Black Sea Area traditional foods

Technological aspects of traditional foods in BaSeFood

Sergey Fedosov
Odessa National Academy of Food Technologies, Odessa, Ukraine

On behalf of the representatives of the beneficiaries of the BaSeFood project and their colleagues who conducted this collaborative research

Traditional Food International (TFI-2012) Cesena, Italy, October 4-5, 2012
An important part of the BaSeFood project has been stipulated by WP4 “Technological-chain effects on bioactives in traditional foods”. The main objectives of the studies were the process optimisation and improved retention of identified key bioactive components in several selected foods from different groups of plant foods in order to promote the production of traditional foods with attached health claims.

Six BaSeFood beneficiaries participated in WP4 with different expertise and roles:

ONAFT, MSUFP, and UFT are research institutions in the Black Sea countries with the main focus on food technological research. UNIBO is a research institution with expertise in characterisation of plant raw materials, analytical chemistry and evolution of specific components after individual unit operations. YEDITEPE and ELKANA are Black Sea beneficiaries contributing by supplying local expertise and samples for investigation.
The selection procedure was based on:

- Evidence based interest from experience of WP participants;
- Confirmatory work carried out during the preliminary surveys;
- Consideration of the list of prioritised traditional foods;
- Preliminary literature reviews;
- In-house expertise and previous experience on specific materials / components;
- Opportunities of integration with stakeholders;
- Cross-country dimension of the interest on specific topics.
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The following species and related foods have been selected for further studies:

Leafy kales

Primitive wheats

Buckwheat

Rye bread

Kvass

Halva

Fruit juices (lingonberry)

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Leafy kales are traditional crops of several areas of Europe (Turkey, Italy, and Portugal). Some aspects of kale utilisation are similar in different countries. So, kales were an adequate subject for cross-cultural comparison. The level of kales exploitation is different in the three countries. So, this crop offered ample possibilities for Black Sea Area stakeholders. Traditional kales use in three countries is the preparation of soups.

There is a considerable interest in consumption of ancient wheats in Western Europe, because of a clear trend to associate primitive wheats with healthy products. Production of primitive wheats survived in several areas (Italy, Turkey, Armenia, Rodopi Mountains in Bulgaria). Emmer and einkorn wheats were chosen as priority crops among primitive wheats.
3. Rye bread

The main criteria for selection of rye bread were its traditionality in some Black Sea countries, presence of useful bioactives, and volume of consumption in the Black Sea countries. Rye bread is the best source of bioactives and dietary fibers from all breads.

4. Buckwheat

Buckwheat porridge (kasha) is a staple food in Ukraine and Russia during many years. The amino acid composition of proteins is well balanced. Buckwheat is a source of micro-, macroelements and dietary fiber. The significant contents of rutin, catechins and other polyphenols, as well as their potential antioxidant activity are of significance to the dietary value of buckwheat. Content of flavonoids in buckwheat is higher than in cereal grains, cabbage, apple, red wine or tea.
5. Kvass

The beneficial effect of kvass was recognized in Russia and Ukraine. To improve organoleptic and healthy properties of kvass, various herbs (mint, tansy, thyme, currant) and spices (cumin, ginger, cloves, cardamom, cinnamon) can be added. Dietary value of kvass is mainly due to the lactic acid.

6. Halva

Tahini halva is widely consumed in Black Sea countries. It is produced from sesame seeds and sugar and rich in bioactive components. There is a possibility to enrich halva with other bioactives from oilseeds and nuts, traditionally not used for production of halva, but recently proved to be rich in fatty acids.

7. Juices

Fruit juices are important sources of bioactive compounds, but techniques used for processing and storage may cause alterations in their contents so they do not provide the benefits expected by consumers. The aim of the studies was preservation of bioactives by modifying processing flow charts.
Bioactive components and dietary fibers studied in selected foods:

<table>
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<th>Leafy kales and related foods</th>
<th>Carotenoids</th>
<th>Phenolics</th>
<th>Glucosinolates</th>
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<td>Primitive wheats and related foods</td>
<td>Dietary fibres</td>
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<td>Rye bread</td>
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<tr>
<td>Juices</td>
<td>Fibres</td>
<td>Vitamins</td>
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Unit operations (critical points) at the processing flow charts

1. Leafy kales and related foods: cooking with water;

2. Primitive wheats and related foods: removing husks, grain crushing, boiling in water;

3. Rye bread: three points during wheat milling and two points during rye milling, two more points during dough preparation and bread baking;

4. Buckwheat: roasting of grains, boiling in water;

5. Kvass: drying of bread, extraction of dried crusts components (wort preparation) by hot water, fermentation of wort by yeast, extraction of juniper berries components, post-fermentation of kvass;

6. Halva: baking of nuts, grinding, duration of halva storage;

7. Juices: traditional technological steps of production;
Comparison of kale populations for their bioactive compound content: phenolics, glucosinolates, carotenoids, and chlorophylls

For the first time, a cross-country comparison of local types of kales has been carried out. Kales have gained increased attention due to their high content of healthy phytochemicals such as carotenoids, glucosinolates (GLS) and phenolics. 25 kale samples were taken from Italian, Portuguese, and Turkish local crops or markets. 15 kale seed samples were obtained from local seed companies or farmers and planted in Cesena. 52 phenolic compounds were identified by HPLC-DAD-MS; 9 of them were non-acylated glycosides of quercetin, kaempferol, and isorhamnetin, 34 were flavonol glycosides acylated with p-coumaric, caffeic, ferulic, hydroxyferulic, and sinapic acid, 4 were non-glycosylated hydroxycinnamic acids and 5 were glycosylated derivatives of phenolic acids. Six major GLS were quantified: glucoiberin (GI), sinigrin (SIN), and gluconapin (GN) as aliphatic GLS, glucobrassicin (GB), methoxyglucobrassicin (MGB), and neoglucobrassicin (NGB) as indolic GLS. Other GLS were not detectable or only in traces.

Pigments identified in kale leaves were lutein and beta-carotene amongst carotenoids, and chlorophylls a and b. It has been found that growing conditions did not consistently influence total phenolic content whereas Portuguese samples showed higher phenolic levels in comparison to Italian and Turkish kales. The results confirm that kales are the more readily available source of glucobrassicin, although with significant variation among populations from different countries.
Boiling in water is a common step in the preparation of kale leaves. This process may lead to significant losses and degradation of phytochemicals. Steaming is an alternative way of cooking. So, the effect of boiling and steaming on the retention factors of kale leaf bioactives was studied. The experimental theses derived from a factorial combination of three kale types, two cooking methods and four cooking times. Bioactives were extracted, quantified by HPLC, and identified by HPLC - mass spectrometry or standard compounds. Analytical determination was also performed on cooking waters. It was found that neither boiling, nor steaming caused chemical degradation of phenolics. A remarkable migration of hydrophilic bioactives (GLS and phenolics) occurred from leaves to cooking waters during boiling. Steaming led to the faster chemical degradation of GLS and chlorophylls in kale samples in comparison to boiling, due to the high exposure of leaves to oxygen.
The term of “primitive wheats” refers to ancient forms of cultivated wheat species (genus *Triticum*). Their production survived in several areas of Western Europe where there is considerable interest in consumption of ancient wheats, especially in organic, specialty, and health food markets. The main considered species were three hulled wheats retaining the glume after threshing. 27 accessions from Armenia, Bulgaria, Georgia, Italy and Turkey, together with 4 commercial durum and bread wheat varieties used as controls, were considered. Grain yield and dry matter content were preliminarily calculated. Lipids were extracted and analyzed, as well as tocols, carotenoids and sterols. Free and bound phenolics were determined. For the first time, the complete range of relevant bioactives in primitive wheats were studied. *T. monococcum* and *T. durum* had the highest level of carotenoids. For *T. monococcum* the lowest sum of free phenolic compounds was obtained, for which the ratio between bound and free phenolic compounds was the highest.
Emmer and einkorn wheat were the two hulled wheats considered within BaSeFood. Glume removal is the preliminary step to human consumption of hulled wheat kernels. An experiment was carried out to compare the traditional processes used in Turkey and Armenia and the updated one found in Italy. On-plant samplings were carried out. The sampled fraction were whole and broken kernels from different sieving fractions. Each fraction was sampled and subsequently used to determine the content and retention of phenolic and lipid associated compounds: tocols, carotenoids and sterols, with respect to whole grain. It was found that the kernel breaking of hulled wheat in traditional and modern processing is substantially different. The whole grains were richer in bioactives and it was noticed that during traditional processing, losses in bioactives occurred in the first generated fractions, while in the Italian plant these were more evident at final stages. In the case of the Italian plant, the wastes from pearling were analyzed too, that resulted the richest in bioactives, especially considering phenolic compounds and phytosterols.
Boiling in water is the cooking used to prepare the most common dishes from emmer wheat. This has therefore been considered as the critical unit operation for bioactive retention. Whole, pearled and crushed grain of two landraces of *T. dicoccum* were subjected to 4 different cooking times. After cooking extraction and study of phenolic and lipid associated compounds (tocols, carotenoids and phytosterols) were performed. This experiment represents the first study of bioactive retention after water cooking of emmer wheat. Carotenoids and tocopherols were partially affected by the boiling in water, while free phenolic compounds decreased rapidly after 20 minutes. Up to 20% of dry matter was found in the cooking water when the crushed grain was boiled. Non-polar components were not found in cooking water, whereas various phenolic acids belonging to the bound fraction were identified.
Emmer products are consumed after boiling in water. The aim of this research was to evaluate the textural changes of emmer wheat used to realize traditional dishes. Cooking time is useful in order to evaluate seeds cooking quality. Longer cooking times, necessary in the case of the whole grain, result in losses of nutrients and could limit end uses, but don’t affect the textural properties (hardness and crispiness). Rheological properties are important parameters which play an important role in cooking seeds. The consumers and processors prefer varieties with low cooking time and low hardness value, characteristics found, in the present research, in pearled and crushed grains.
Within BaSeFood project 7 oilseeds and nuts were sampled and analytically characterised with respect of their bioactive compound content and oxidative quality (peanuts, almonds, walnuts, hazelnuts, sesame, sunflower and pumpkin seeds). Samples were characterised for the lipidic (fatty acids, sterols, tocopherols) and phenolic compounds (polyphenols).

All seeds showed high amount of lipids with oleic acid and linoleic acid as predominant contributors.

Free sterols were present in all oilseeds with high levels in sesame and sunflower seeds. β-sitosterol was detected as the most abundant sterol in all samples; sesame, sunflower seeds and peanuts had the highest relative contents of campesterol and stigmasterol. Stanols were also found.

From sterols, tocols were present in higher amount in sesame seeds, followed by sunflower and peanuts.

Peanuts, almonds, hazelnuts and sunflower seeds had high percentage of α-tocopherol.

Walnuts and pumpkins had γ-tocopherol as predominant compound. Sesame showed traces of tocopherols, but they were the richest in β- and γ-tocotrienols.
Tahini halva is rich in bioactive compounds that may be affected by processing. The samples analysed were seven different raw seeds, roasted seeds, tahini and halva. All samples were characterised for lipidic and phenolic bioactives. The oxidation and antioxidant capacity were also evaluated. The analysis was carried out at all steps of processing: native seeds, roasted seeds, seed paste, and halva. In general, the fatty acid profile was the same from raw seeds to halva with a small increase of polyunsaturated fatty acids for many oilseeds. Sterols and tocopherols did not show particular differences during processing. Most of the samples showed more peroxides after roasting and decrease of them in halva. Except for pumpkin seeds, the antioxidant activity was the highest in halva. Until now no studies were carried out on bioactive compounds content and health benefit of halva, so this research was the first study for halva obtained from different oilseeds and nuts. It was found that traditional processing affects in part the bioactive compounds content, with roasting and grinding being the main unit operations responsible for some losses. These are also the main causes of the oxidation increase of halva.
Oxidation and bioactive compounds evolution and retention during oilseeds tahini and halva shelf life

Oxidation may occur during storage of halva. Therefore, the shelf life evaluation and bioactive retention of tahini and halva from different oilseed raw materials was studied. Tahini and halva samples were stored at typical conditions for traditional procedures. Periodically the following determinations were carried out: peroxide value, conjugated diens and triens, tocopherol and tocotrienols, polyphenols and antioxidant activity. Most of the samples increased the peroxide content after 3 months of shelf life and halva has lower value than tahini. Sunflower and pumpkin seeds halva reached the legal limit for food lipids. The antioxidant activity decreased after roasting and grinding, whereas it became higher in the final halva. Walnuts showed the highest values for all the products. These results show that the duration of storage is an important factor that should be investigated in all lipidic foods. Besides the storage conditions like temperature and light, the raw material quality is also very important.
Comparative study on food sensory characteristics of traditional and new products based on oleaginous products

Sensory profiles of traditional sunflower and sesame tahini halva were developed by trained panellist. Differences are identified between the flavour, colour and texture profiles of traditional tahini halva and samples made of walnut, hazelnut, pumpkin seeds, peanuts and almonds. The development of new products based on oleaginous products contributes for their popularization and increasing their usage.

Development of new tahini based products, enriched with biologically active components from local plants

Tahini is a traditional product, mainly used in the production of halva. Two groups of new products were developed: paste type (spreads) and bakery. Four types of tahini (sunflower, almond, hazelnut, walnut) were used. Culinary application of the new products were suggested that can be used to update the food service facilities menus with healthy and interesting products.
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Traditional flow chart of kvass preparation

1. Rye bread cut into small pieces
2. Dry in oven over low heat
3. -Transfer in steel pan, cover with lid
   -Drawn for 24h at 25-30°C
   -Wort filtered through a sieve + Recovering of additional wort from drawned rye bread pieces through gauze
   -Dissolve in a small portion of wort and poured back in the mixture
4. Pan covered with a towel, mixture fermented for 13-16h (25 – 30⁰C)
5. Bottle
   Store (4-6°C, 2-3days)

- Small quantity just before fermentation ends
- Juniper berries
- Boiling (30 min)
- Cooling
- Straining

Modifications: 1. Concentrate of the kvass wort is used instead of dried crusts of rye bread;
2. Lactic acid bacteria are used in addition to bakery yeast for the fermentation of the wort.

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Conclusions:
1. Kvass produced by modified flow chart has higher coloration.
2. Lactic acid bacteria grow more intensively than in traditional kvass.
3. Modified kvass has lower content of dry matter.
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Traditional flow chart of rye bread production

1. Pure culture of homo fermentative thermophilic lactic acid bacteria are used instead of mixed cultures of lactic acid bacteria and yeast.

2. Buckwheat flour is used instead of wheat flour.

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Modified flow chart

Conclusions:

1. Modified bread has higher content of dietary fibers and lactic acid than traditional bread;

2. Physico-chemical and organoleptic indicators of traditional and modified bread are the same.
Hypotheses on how to modify the traditional flow chart in order to increase content of bioactives in bread

1. By outer parts of grains.
2. By mixing of wheat flour with the rye, buckwheat, barley, oat, corn and triticale flour
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Scheme of testing performed in order to develop a new technology for production of wheat flour with increased biological value

1. Effectiveness parameters of mixing different fractions of peripheral parts of wheat grain (bran) with flour of graded milling

2. Effect of disperse composition of bran on baking properties of their blends with flour of good quality

3. Investigation of specific role of enzymes in changing the baking properties of flour

4. Optimization of mixing high quality flour with bran

Technology of wheat flour production with high content of bran (DF and BAC)

Technology of flour production with high content of bran under many-graded wheat grinding (75%)

Technology of production of flour “Odessa” The production test technology of flour, “Odessa” at-grade milling wheat
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The diagram of flour production with the high content of bran. Flour of the 1st or the 2nd grade, after controlling for screening is sent to the storage bin, and bran in the hopper; flour and bran are dosed and sent to a collecting conveyor, then to the mixer of A9-DSG type where it is thoroughly mixed with bran for 2-3 min. The finished product is flour with the high content of bran. It is fed into the hopper, weighed and fed to the finished-products storage area.
Tsiteli Doli Bread

Yeast 1-1,5 % to overall amount of flour in dough

Salt 1-1,5 % to overall amount of flour in dough

Warm water (40 °C) 35-40% to overall amount of dough

Tsiteli Doli wheat flour

Knead the dough for minimum 10 minutes, cover with a cloth and set aside.

Leave the dough for fermentation during 120 minutes at 28-30 °C. (When the dough raises after about 60 minutes, press and leave for another 60 minutes)

Form the dough in 450 - 500 g parts

Keep off dough half-finished products for 10 -15 minutes

Bake the bread for 35 minutes at 220-230 °C

Ready bread
Dika Bread

Yeast 1-1.5% to overall amount of flour in dough

Salt 1-1.5% to overall amount of flour in dough

Warm water (40°C) 35-40% to overall amount of dough

Dika wheat flour

Knead the dough for minimum 10 minutes, cover with a cloth and set aside.

Form the dough in 450-500 g parts

Keep off dough half-finished products for 10-15 minutes

Bake the bread for 35 minutes at 220-230°C

Ready bread

Leaves the dough for fermentation during 120 minutes at 28-30°C. (When the dough raises after about 60 minutes, press and leave for another 60 minutes)
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Tsiteli Doli Bread with Makhoebeli

- Floured makhoebeli (cephalaria cyriaca), preliminary dissolved in warm water, 2% to overall amount of flour in dough
- Yeast 1-1.5% to overall amount of flour in dough
- Salt 1-1.5% to overall amount of flour in dough
- Warm water (40°C) 35-40% to overall amount of dough

Tsiteli Doli wheat flour

Knead the dough for minimum 10 minutes, cover with a cloth and set aside

- Leave the dough for fermentation during 120 minutes at 28-30°C. (When the dough raises after about 60 minutes, press and leave for another 60 minutes)
- Form the dough in 450-500 g parts
- Keep off dough half-finished products for 10-15 minutes

Bake the bread for 35 minutes at 220-230°C

Ready bread

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Tarhana is a traditional fermented cereal based Balkan food. Specific characteristics of the technology and ingredients of tarhana were studied, and the effect of the fermentation and type of flour on physical, chemical and microbiological characteristics. Three samples of tarhana were studied, prepared by traditional technology. It has been found that tarhana is a good source of protein, vitamins, minerals, and some compounds (lycopene, carotenoids, pectins) possessing functional properties.

Food sensory characteristics of traditional Bulgarian fermented beverages based on wild fruits

Sensory profiles were developed of a fermented lingon berry Bulgarian beverage “ljuto” made by traditional (1) and modified technology (with 8% sugar in the media (2) and with 8% sugar and yeast (3)) to enhance the fermentation process and better preserve biologically active components. Juices were evaluated by a group of trained food beverage sensory experts. There was a statistically significant difference perceived by the respondents between sample (3) and the traditional “ljuto” (1), while samples (2) and (1) were difficult to be distinguished.
“Ljuto” is a traditional Bulgarian beverage, produced of wild fruits through a process of fermentation. The effect of technological parameters on the biological activity of the beverage was studied. The effect of modification of substrates (Sample 1 - traditional, Sample 2 - 8% sugar; Sample 3 – 8% sugar and yeasts) on the composition of ljuto was studied. Time for fermentation was shortened by a week, compared to the traditional technology. The process of extraction of nutrients and biologically active components was enhanced; it was more markedly expressed when sugar and yeasts were added to the substrate. The bioactive components of lingon berries were well preserved in all three variants of the beverages.
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Effect of processing on some biologically active components in selected Bulgarian traditional foods

The technological scheme for production of tahini involves cleaning of seeds, separation of the nut from the husk, roasting, cooling and grinding of nuts to tahini mass. Effect of temperature and duration of heating was studied. Samples were heated at 100, 120, 140 °C for 2 hours with taking samples every 30 min. The total oil content was determined and fatty acid composition was investigated. Oxidative stability was also measured and tocopherols were analyzed. Significant changes were observed in the taste, colour and friable characteristics. The study contributed to improvement of the process of tahini and halva production.

Biologically active components in Bulgarian traditional foods with pumpkin (Cucurbita moschata)

Pumpkin reach in carotenoids is a basic ingredient of a variety of traditional Bulgarian foods. It is boiled, fried, stewed or baked during the preparation of foods. Seven carotenoids and carotenoid esters were indentified. Heating resulted in reduction of the total carotenoids most significantly after 2 h of treatment. The study of biologically active components of pumpkin will help in better preservation of Bulgarian traditional foods.
CONCLUSIONS

In general, all tasks stipulated by the Work Package 4 of the BaSeFood project have been fulfilled.

Seven foods were selected from different groups of plant foods. Key bioactive components were identified.

Due to optimisation of processing parameters and modification of flow charts, retention of key bioactive components were improved.

A few new varieties of the selected foods were developed and tested.

Thus, the necessary foundation has been created for the production of traditional foods with attached health claims.
THE PRESENTATION IS OVER

Thank you very much for your attention!