Gassy Ozone Effect on Quality Parameters of Flaxes Made from Biologically Activated Whole Wheat Grains

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Abstract—The aim of the current research was to investigate the gassy ozone effect on quality parameters of flaxes made form whole biologically activated wheat grains. The research was accomplished on wheat grains variety 'Zentos'. Grains were washed, wetted; grain biological activation was performed in the climatic chamber up to 24 hours. After biological activation grains were compressed; then flaxes was dried in convective drier till constant moisture content 9±1%. Grains were treated with gassy ozone (concentration 0.0002%) for 6min. In the processed flaxes the content of α and γ tocopherol decrease by 23% and by 9%; content of B2 and B6 vitamins – by 11% and by 10%; elaidic acid – by 46%, oleic acid – by 29%; arginine (by 80%), glutamine (by 74%), asparagine and serine (by 68%), valine (by 62%), cysteine (by 54%) and tyrosine (by 47%).

Keywords—Gassy ozone, flaxes, biologically activated grains, quality parameters, treatment.

I. INTRODUCTION

WHOLE-GRAIN cereals contain a much wider range of compounds with potential antioxidant effect than do refined cereals. These include vitamin E (mainly in the germ), folates, minerals (iron, zinc) and trace elements (selenium, copper and manganese), carotenoids, phyto acid, lignin and other compounds such as betaine, choline, sulphur amino acids, alkylresorcinols and lignans found mainly in the bran fraction. Some, such as vitamin E, are considered to be direct free radical scavengers, while others act as cofactors of antioxidant enzymes (selenium, manganese and zinc), or indirect antioxidants (folates, choline and betaine) [1].

Since 1980 the Dietary Guidelines have been published jointly every five years by the Department of Health and Human Services (USDHHS) and the Department of Agriculture (USDA). From the beginning, these recommendations have encouraged consumption of whole-grains for a healthy diet. The 2005 Dietary Guidelines, however, marked a signifiant departure from past recommendations by making specific recommendations about whole-grains – which at least half of a person’s daily grain intake should come from whole-grains [2].

Wheat is a member of the Triticeae group of cereals and indisputably one of the major food crops of the world and a foundation of human nutrition worldwide. In addition to its basic caloric value, wheat, with its high protein content, is the single most important source of plant protein in the human diet [3]. Wheat is mainly consumed as sifted white flour, although it is well known that health-promoting components, including dietary fibre, are concentrated in the bran [4].

For the increasing of grains nutritive value germination for several days or biological activation for 24 hours is necessary. During the activation time dietary fibre content has increased. The amount of vitamin B2 increased by 54.5%, vitamin E content grown 6.5 times, and the content of niacin increased 1.3 times. Vitamin C was not found in inactivated grain samples, but during the activation process by means of biochemical reactions it was synthesized – 71.0mg/kg in wheat grain. However, total content of amino acids decreased by 17.4% in wheat grain during the grain activation time up to 24 hours [5].

There are reported incidents of food poisoning resulting from contaminated flour. Australian, European and US studies indicate that Salmonella spp., Escherichia coli, Bacillus cereus and spoilage microorganisms are present in wheat and flour at low levels [6]. At the same time during biological activation microorganisms grow is stimulated, therefore flaks from biologically activated wheat grains could not be safety as for consumption, as for other food production application. Some researchers offer to use grains treatment with ozone for insuring high quality food and for inactivation of microorganism or slowing they grow [7].

Ozone (O3) is a strong oxidant recognized since 1997 as a generally recognized as safe substance and used in a number of applications in the food industry for destruction or detoxification of chemicals or microorganisms. These applications include the surface decontamination, storage and preservation of perishable foods as well as water or manufacturing equipment and packaging sterilization [8],[9]. Ozone in gaseous or aqueous form is reported to reduce levels of the natural microflora, as well as bacterial, fungal and mould contamination in cereals and cereal products, including spores of Bacillus, Coliform bacteria, Micrococcus, Flavobacterium, Alcaligenes, Serratia, Aspergillus and Penicillium. Ozone is not universally beneficial and in some cases may promote oxidation degradation of chemical constituents present in the grains. Surface oxidation, discoloration or development of undesirable odors may occur from excessive use of ozone. However, higher ozone
concentrations (>50ppm) cause considerable oxidative damage to cereal grains [10].

In our experiments it was found, that optimal grain processing parameters with ozone for maximal microbiological safety and optimal germinating power were for triticale grains – 3.92mg/m² 8 min, for hull-less barley grain – 11.76mg/m² 6min. Ozone concentration and treatment time not significantly influence changes in grain protein, moisture, starch and β-glycan content; however significantly influence grain germinating power; germinating power of processed triticale grains increase after three days germination by 15% and after five days germination by 7%; of processed hull-less barley grains – after three days germination by 11% and after five days germination by 9%. Ozone significantly influences grain starch microstructure, as a result starch granules swell up, its volume increase. The amount of mycotoxins before and after grain treatment with gassy ozone was under detection layer [11].

After summarizing of scientific data from literature the aim of the current research was developed as follow – to investigate the gassy ozone effect on quality parameters of flaxes made form whole biologically activated wheat grains.

II. MATERIALS AND METHODS

A. Materials
The research was accomplished on in Year 2012 from Latvia University of Agriculture research station „Peteralauki” (Latvia) harvested wheat grains variety ‘Zentos’.

B. Grain Biological Activation, Flaxes Making
Grains were washed (H₂O t = +20±1°C), wetted (H₂O t = +20±1°C, τ = 24±1h), grain biological activation was performed in the climatic chamber at temperature +25±1°C and constant relative air humidity – 80±1% up to 24±1h [5].

After biological activation grains were compressed using electric flaker (Hawos, Germany). Than flaxes was dried in convective drier with forced air circulation at 50±1°C till constant moisture content 9±1%.

C. Flaxes Treatment with Gassy Ozone
In current research, a gassy ozone ozonizer “OZ-15G” (China) was used for grain treatment and “IKG-6Zentos” (Russia) was collected, dried and weighed. The protein and ash content might remain in the fiber [19].

D. Protein Content
The total protein content was determined by Kjeldal method [12] according to the LVS ISO 8968-5:2002.

E. Amino Acids
Amino acids were determined [13] according to LVS SS-EN ISO 13903:2005.

F. Fatty Acids
Fatty acids were determined according to LVS EN ISO 5508:1995.

G. Vitamin E
The content of vitamin E was determined using liquid chromatography with high performance mass spectrometry (HPLC) [14].

H. Tocopherol

I. B Group Vitamins
The content of vitamin B₁₂ was determined using AOAC Official Method 970.65 [16]; of vitamin B₆ [17] and vitamin B₉ [18] using microbiological standard method.

J. Dietary Fibre
The total dietary fiber in these samples was determinate according AOAC approved method No 985.29. The experiments were carried out by using FOSS Analytical Fibertec E 1023 system providing enzymatic processing by incubation in thermostatic shaking water bath, residue filtration by Filtration Module and protein determination by Kjeldahl nitrogen equipment. The analyses were performed in three repetitions. The samples were defatted and dried with a particle size less than 0.5mm. After, each sample was enzymatically digested with α-amylase incubation at 100°C, as well as protease and amyloglucosidase incubation at 60°C. After digestion the total fiber content is precipitated by adding 95g 100/g ethanol. Later the solution was filtered and fiber was collected, dried and weighed. The protein and ash content were determined to correct any of these substances which might remain in the fiber [19].

K. Mathematical Data Processing
Data are expressed as mean ± standard deviation; for the mathematical data processing p-value at 0.05 (One Way analysis of variance, ANOVA), was used to determine the significant differences. In case of establishing statistically significant differences, homogeneous groups were determined by Tukey’s multiple comparison test the level of confidence α=0.05. The statistical analyses were performed using Microsoft Excel 2007.

III. RESULTS AND DISCUSSION
According to the literature, treatments with ozone significantly influence not only microbiological quality, but also chemical composition of grains [11].

Proteins, fiber and total sugar content of flakes made from biologically activated grains before and after treatment with ozone was not changed (see Table I) significantly (p>0.05) and this statement match with other researchers’ conclusions [7], [20].

In a three-year study carried out at a rural site in Switzerland, spring wheat was exposed to different levels of ozone (O₃) in open-top-field chambers from the two-leaf stage until harvest. Grain recovered from the different treatments was analyzed for minerals (Ca, Mg, K, and P), starch, protein, amino acids and α-tocopherol, in order to investigate the effect of O₃ on grain composition.
B6 significantly increase (p<0.05). The content of vitamin B2 after treatment with ozone was determined in produced flakes vitamins [5], therefore, content of these vitamins before and too (see Table III).

As a result no effect of ozone on the content of α-tocopherol and on the essential amino acid index of the protein was observed. It is concluded that compositional changes in wheat grain in response to ozone are minor, and that ambient ozone is not likely to cause important changes [20].

Content of α-tocopherol significantly decrease (p<0.05) by 23% in wheat flakes after treatment with ozone γ-tocopherol decrease too, but insignificantly (by 9%). These negative changes can be explained with fact, that α and γ-tocopherol becomes unstable in higher temperature and after treatment with oxygen [21]. Stability of tocopherol and tocotrienol extracted from unsaponifiable fraction (of grains under various temperature and oxygen condition), flakes was treated with ozone, as results vitamins are oxidized.

Biologically activated grains are sources of B group vitamins [5], therefore, content of these vitamins before and after treatment with ozone was determined in produced flakes too (see Table III).

Comparing grains before biological activation and flakes after treatment with ozone still content of vitamins B3 and B6 was higher accordingly by 17% and by 61% times, but content of B12 was the same in all analyzed samples (Table III).

The content of fatty acids decreased in all analysed samples after treatment with ozone, except palmitic acid, linoleic acid and linolenic acid (see Table IV). Content of these fatty acids changed the margin of error. Decrease content of fatty acids evaluated negatively, treatment regime (concentration of ozone and time) significantly (p<0.05).

In wheat highest was B2 vitamin content – 0.45mg/100g, but lowest B12 vitamin content – 0.02mg/100g, according to the literature [5] content of B2 vitamin can range from 0.35 to 0.43mg/100g and B6 vitamin from 0.15 to 0.19mg/100g. After biological activation of grains, the content of vitamin B2 and B6 significantly increase (p<0.05). The content of vitamin B2 increases by 26%, but of B6 – by 65%. These data is according to the other research results, where authors found, that during grains biological activation content of B group vitamins increase [5].

Greatest decrease was detected in elaidic acid and oleic acid concentrations; accordingly it was by 46% and by 29% comparing to samples before treatment. This decrease can be evaluated negatively still it is known, that these fatty acids are very important in grain and grains’ products. Such results don’t coincide with other researcher results, where was
detected, that ozone have no influence on fatty acids concentration [7].

After research results, it can be concluded, that ozone is very strong oxidant, as result fatty acids concentration significantly decrease.

Content of individual amino acids significantly decrease (p<0.05) after treatment with ozone (see Table V). Greater decrease was detected in a case with arginine (by 80%), glutamine (by 74%), asparagine and serine (by 68%), valine (by 62%), cysteine (by 54%) and tyrosine (by 47%).

Decrease concentration of amino acids evaluated negatively, still it is known that essential acids are very important nutritionally.

IV. CONCLUSIONS

Content of α and γ tocopherol in flakes made from biologically activated whole wheat grains decrease by 23% and by 9% after treatment with ozone.

Content of B₂ and B₆ vitamin in flakes from biologically activated wheat grains decrease by 11% and by 10% after treatment with ozone, but content of vitamin B₁₂ remained unchanged. Concentration of fatty acids in flakes made from biologically activated wheat grains decrease; oleaefic acid – by 46%, and oleic acid – by 29%.

Content of individual amino acids significantly decrease (p<0.05) after treatment with ozone. Greater decrease was detected in a case with arginine (by 80%), glutamine (by 74%), asparagine and serine (by 68%), valine (by 62%), cysteine (by 54%) and tyrosine (by 47%).

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