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# Effect of Dry Goji Berry and Pumpkin Powder on Quality of Cooked and Smoked Beef with Reduced Nitrite Content

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**Abstract:** The colorant and antioxidant activity of dried fruits of Goji Berry (GB) (Lycium chinense) and/or butternut Pumpkin Powder (PP) (*Cucurbita moschata*) can be used for reduction of part of nitrites in cooked and smoked meat products. Since many of these natural biological active substances are consumed together and probably have the potential for synergistic interactions. The objective of this study was to establishe the potential of to concentrations 0.5 and 1.0% of GB and/or PP separately or in combinations, as additives for processing of cooked and smoked beef striploin with $^1/_2$ reduced nitrite content. The separate use of GB or PP leads to certain abnormalities in sensory quality and technological properties but the addition to the pikle a combination containing 1.0% of GB and 0.5% PP guarantee good quality, nise sensory properties and colour characteristics and inhibite the oxidative changes in cooked and smoked beef striploin with a half reduced amounts of nitrites.

**Keywords:** Autolysis, color, cooked striploin, nitrites' reduction, oxidation, sensory properties

## INTRODUCTION

Consumers demand healthier meat products that are low in salt, fat, cholesterol, nitrites and calories in general and contain in addition health-promoting bioactive components such as carotenoids, sterols and fibers. Thay expect these novel meat products with altered formulations to taste look and smell the same way as their traditionally formulated and processed counterparts (Weiss *et al*., 2010). Recent innovations in the meat industry are based on either reducing the content of unhealthy substances i.e., less added nitrate and nitrite (Toldrá and Reig, 2011). In most countries the use of nitrates and nitrites is limited and regulated by laws. The nitrite inhibits outgrowth and neurotoxin formation by *Clostridium botulinum*, delays the development of oxidative rancidity, develops the characteristic flavor of cured meats, reacts with myoglobin and stabilizes the red meat color (Viuda-Martos *et al*., 2009). In the stomach nitrite can eventually form carcinogenic nitrosamines (Honikel, 2008). All these influences invoke the thought that meat products can not be completely derived of nitrites. Reducing the nitrite concentration can result a discoloration, reducing the shelf life and deterioration of the sensory characteristics in cooked and smoked meat products (Sebranek and Bacus 2007). That is way Osada *et al*. (2000) tried to reduce the cholesterol oxidation in meat products by supplementation of sodium nitrite and apple polyphenol. For this purpose Viuda-Martos *et al*. (2009) used citrus co-products and O'Keefe and Wang (2006) applied peanut skin extract. Rosemary (Rohlik and Pipek, 2011, 2012) and mango seed (Fernandes Pereira *et al*., 2011) extracts have been used also. No information about application a PP or GB as colourants and antioxidants in meat products. Pumpkin is a rich source of β-carotene (>80%). It contains lesser amounts of lutein, lycopene, α-carotene and *cis*-β-carotene (Seo *et al*., 2005), alkaloids, flavonoids, palmitic, oleic and linoleic acids (Yadav *et al*., 2010). Goji berry fruits contain 23% polysaccharides known as proteoglycans (Potterat, 2010). Second major groups are carotenoids (zeaxanthin dipalmitate represents 56% of the total carotenoids in the fruit). Zeaxanthin monopalmitate, β-cryptoxanthin palmitate, small amount of free zeaxanthin and β-carotene are also present. The fruits further contain riboflavin, thiamin and ascorbic acid. Flavonoids are another important class of compounds, including the aglycones myricetin, quercetin and kaempferol. The hexadecanoic acid, linoleic acid, β-elemene, myristic acid and ethylhexadecanoate, among the nonpolar constituents, a series of glycerogalacto lipids have been recently isolated, too. The fruit further

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contains 1.0-2.7% free amino acids mainly proline. The non-proteinogenic amino acids taurine and γ-aminobutyric acid, as well as betaine (trimethylglycine) are also presented. Finally, some miscellaneous compounds have been isolated including β-sitosterol and its glucoside daucosterol, scopoletin, p-coumaric acid, the dopamine derivative lyciumide A and L-monomenthyl succinate (Potterat, 2010). Cooked and smoked beef striploin beef is prone to both colour and oxidative spoilage. Therefore it is desirable to use plant substances with both antioxidant and colorant properties. Pumpkin powder alone has comperatively good antioxidant activity but unusual yellow-orange color, while goji berry alone showed relatively moderate antioxidant activity, but excellent red colorant properties. Therefore, the potential of GB and PP, as additives for processing of cooked and smoked beef fillet with $^1/_2$ reduced nitrite content, was the purpose of this study.

## MATERIALS AND METHODS

**Materials:**

**Beef:** The fresh (48 h *post mortem*) chilled to 4ºC beef striploins with pH 6.60, were supplied by the company Dimitar Madgarov-1 Ltd, Plovdiv, Bulgaria.

**Ingredients and additives:** The sodium chloride (salt), Sodium Tripolyphosphates (STPP), sodium nitrite (E250), fresh goji berry (*Lycium chinense*) fruits and butternut pumpkin (*Cucurbita moschata*) were bought from the local market. The goji berry fruits were dried in the Department of Processes and Apparatus from University of Food Technologies, Plovdiv, Bulgaria. The dry fruits were grinded before use.

The butternut pumpkin was cleaned of peel and seeds, shredded into small particles and dried in a spray dryer in the Department of Heat Engineering from University of Food Technologies, Plovdiv, Bulgaria.

**Methods:**

**Sample preparation:** Fresh beef striploins were injected with 20% brain, containing ingradients and additives are shown in Table 1. The injected beef striploins were ripened a night at 0-4°C. The matured injected beef striploin was tumbled for 5 min and was put in trolleys. The so salted beef striploin was smoked at 68°C, cooked to a center temperature 72°C and was chilled on refrigerator. One third of the smoked beef fillets were packed in oxygen-permeable bags. The other two-thirds were vacuum-packaged in impermeable nylon/polyethylene bags ($O_2$ permeability, 9.3 $mLO_2/m^2/24$ h at 8ºC; Koch, Kansas City, MO, USA) using a vacuum packager model AG-800 (MultiVac, Wolfertschwenden/Allgau, Germany).

First third of the samples was immedialy studed (1 d of experiment). The second third was stored at 0-4ºC 2 days (3 d of experiment) and the third part was stored at the same temperature 5 days (6 d of experiment) resp. The samples were obtained according ISO 3100-1:1991.

**Sensory analysis:** The sensory characteristics of the samples were determined by a panel consisting of five members with proven tasting abilities was used. The panelists were passed the triangular test for differentiation of fresh and rancid sausage flavor, odor and color (Grobbel *et al*., 2008). The samples were scored using 1 to 5 scales.

**Color properties establishment:** Colourimeter Konica Minolta model CR-410 (Konica Minolta Holding, Inc., Ewing, New Jersey, USA) was used to evaluate the lightness (L* value), red component (a* value) and yellow component (b* value) of the color (Hunt *et al*., 2012). Further, the changes of the color properties of surface cross-sectional views of the samples smoked beef striploins were held on the 6$^{th}$ day of storage captured in dynamics during the 60 min of air exposure.

**Determination of free amino nitrogen:** The modified titration method of Sørensen (Lorenzo *et al*., 2008) was used for determination of free amino nitrogen in samples.

**Determination of total protein carbonyls:** A protein oxidation was measured by estimation of carbonyl groups formed (Mercier *et al*., 2004) with some modifications. Each sample of homogenate was divided into two equal aliquots of 0.5 mL. Proteins were precipitated in both aliquots by 10% trichloroacetic acid (w/v) and centrifuged at 2000 g for 10 min. One pellet was treated with 1 ml of 2N HCl and the other with an

Table 1: Content of brain solutions used for injection of different samples fresh beef striploins

| | Constituents, % | | | | | |
|---|---|---|---|---|---|---|
| Samples | Drinking water | Sodium chloride | Sodium tripo-lyphosphate | Sodium nitrite | Dried goji berry fruits | Pumpkin powder |
| C | 100.00 | 5.00 | 2.00 | 0.06 | - | - |
| C½ | 100.00 | 5.00 | 2.00 | 0.03 | - | - |
| $GB_1$ | 100.00 | 5.00 | 2.00 | 0.03 | 0.50 | - |
| $GB_2$ | 100.00 | 5.00 | 2.00 | 0.03 | 1.00 | - |
| $PP_1$ | 100.00 | 5.00 | 2.00 | 0.03 | - | 0.50 |
| $PP_2$ | 100.00 | 5.00 | 2.00 | 0.03 | - | 1.00 |
| $GB_1PP_2$ | 100.00 | 5.00 | 2.00 | 0.03 | 0.50 | 1.00 |
| $GB_2PP_1$ | 100.00 | 5.00 | 2.00 | 0.03 | 1.00 | 0.50 |

equal volume of 0.2% (w/v) DNPH in 2N HCl. Both samples were incubated for 1 h at room temperature and stirred regularly. The samples were precipitated with 10% TCA (w/v final concentration) and centrifuged at 2000 g for 10 min. The pellets were then washed twice with 1 ml of ethanol-ethylacetate (1:1) to eliminate traces of DNPH and to make soluble residual lipids. Proteins were finally dissolved, in 2 mL of 6 M guanidine HCl with 20 mM sodium phosphate buffer pH 6.5. To remove insoluble fragments, samples were centrifuged 10 min at 2000 g. Protein concentration was calculated at 280 nm in the HCl control using BSA in 6 M guanidine as standard. Carbonyl concentration was measured on the treated sample by measuring DNPH incorporated on the basis of an absorption of 21.0/mM/cm at 370 nm for protein hydrazones. The results were expressed as nanomoles of DNPH fixed per milligram of protein.

**Determination of the degree of lipolysis by acid value:** As a standard of the rate of lipolysis, the Acid Value (AV) of the extracted lipids was measured following EN ISO 660:2001 procedure (Kardash and Tur'yan, 2005).

**Determination of degree of lipid oxidation by 2-thiobarbituric acid reactive substances:** TBARS were determined by the method described by Botsoglou *et al*. (1994). The duble beam UV-VIS spectrophotometer Camspec model M550 (Camspec Ltd, Kembridge, UK) was used.

**pH determination:** pH of the samples was determined by pH-meter Microsyst MS 2004 (Microsyst, Plovdiv, Bulgaria), equipped by combined pH electrode Sensorex combination recorder S450CD (Sensorex pH Electrode Station, Garden Grove, CA, USA) (Young *et al*., 2004).

**Statistical analysis:** The data of different samples were analyzed independently by SAS software (SAS Institute Inc., 1990). The Student-Newman-Keuls multiple range test was used to compare differences among means. Mean values and standard errors of the mean were reported. Significance of differences was defined at $p \leq 0.05$.

## RESULTS AND DISCUSSION

**Sensory evaluations:** On the 6$^{th}$ d of storage at 0-4ºC the maximal sensory scores of flavor, odor and color were awarded in the control samples C (Table 2). Exclusively the sensory properties of samples $GB_2PP_1$ were not different statistically significantly ($p>0.05$) than the control sample C was faund. No statistically significant ($p>0.05$) differences, compared with the control samples C were estimated about the color samples $GB_1PP_2$, too (Table 2). The lowest sensory scores the panel was awarded of samples $PP_2$ and C½. Those results allow us to conclude that addition of 1.00% GB plus 0.50% PP in the brain at most significant extend contributes to the preservation of the fresh colour, smell and taste of 6$^{th}$ d storaged cooked and smoked beef striploin processed with a half reduction of nitrite content. Similarly of our findings O'Keefe and Wang (2006) established the good effect of peanut skin extract on quality and storage stability of beef products.

**Changes of the colour characteristics:** During the 6$^{th}$ d storage at all examined samples the statistically significant ($p \leq 0.05$) inreaing of color lightness (L* value), redness (a* value) and yellowness (b* value) were determined (Table 3). At the beginning of the experiment (1 d) the L * values of samples $GB_2PP_1$ and C½ were not statistically significantly ($p>0.05$) different from that of the controls C. During further six day storage at 0-4ºC only L* values of samples $GB_2PP_1$ were kept statistically significantly ($p>0.05$) equal to that of the control sample C.

Similar results were also identified regarding changes to the red component of the color. The a* values of samples $GB_2PP_1$ were kept statistically significant ($p>0.05$) indistinguishable to that of the control sample C during all 6 days period of storage. On the 6$^{th}$ d of experiments the statistically significant ($p>0.05$) differences between a* values of samples $GB_2$, $PP_1$, $GB_2PP_1$ and C were not estimated, too (Table 3).

The b* values of samples $GB_2PP_1$ and $PP_2$ were kept statistically significant ($p>0.05$) indiscernible compared with the control sample C during all 6 days

Table 2: Sensory evaluations of surface cross-sectional color, flavor and odor of the samples cured beef striploin on 6$^{th}$ d of storage at 0-4°C

| | Sensory evaluations | | |
|---|---|---|---|
| Samples | Color of the surface cross-sectional view | Odor | Flavor |
| C | 5.00±0.02$^{a}$ | 5.00±0.03$^{a}$ | 5.00±0.04$^{a}$ |
| C½ | 3.20±0.09$^{f}$ | 3.50±0.10$^{e}$ | 3.90±0.05$^{g}$ |
| $GB_1$ | 4.50±0.06$^{d}$ | 4.50±0.08$^{d}$ | 4.40±0.06$^{e}$ |
| $GB_2$ | 4.75±0.04$^{c}$ | 4.70±0.03$^{c}$ | 4.65±0.05$^{c}$ |
| $PP_1$ | 3.50±0.08$^{e}$ | 3.40±0.09$^{e}$ | 4.20±0.10$^{f}$ |
| $PP_2$ | 2.50±0.07$^{g}$ | 2.50±0.12$^{f}$ | 2.80±0.13$^{h}$ |
| $GB_1PP_2$ | 4.85±0.06$^{a,b}$ | 4.80±0.06$^{b}$ | 4.75±0.09$^{b,c}$ |
| $GB_2PP_1$ | 4.95±0.05$^{a}$ | 4.90±0.07$^{a,b}$ | 4.90±0.07$^{a,b}$ |

Means ± standard deviations; $^{a, b, c, d, e, f, h}$: Different letters on the means denote statistical differences amongst samples by columns ($p \leq 0.05$)

Table 3: Changes of the color characteristics (L*, a*, b*) of the cross-sectional surface view of samples cured beef striploin

| | | Storage time at 0 -4ºC | | |
|---|---|---|---|---|
| Colour characteristics | Samples | 1 d | 3 d | 6 d |
| L* | C | 49.66±0.11$^{e}$ | 52.70±0.22$^{l}$ | 53.44±0.18$^{m}$ |
| | C½ | 49.65±0.20$^{e}$ | 50.28±0.24$^{g}$ | 50.78±0.28$^{h}$ |
| | $GB_1$ | 48.28±0.12$^{c}$ | 50.02±0.11$^{f}$ | 52.71±0.17$^{l}$ |
| | $GB_2$ | 50.46±0.21$^{g,h}$ | 51.47±0.23$^{j}$ | 52.42±0.19$^{k,l}$ |
| | $PP_1$ | 47.23±0.10$^{a}$ | 47.71±0.12$^{b}$ | 48.94±0.16$^{d}$ |
| | $PP_2$ | 47.20±0.17$^{a}$ | 47.89±0.14$^{b}$ | 48.31±0.13$^{c}$ |
| | $GB_1PP_2$ | 48.92±0.19$^{d}$ | 49.67±0.23$^{e}$ | 50.35±0.22$^{g}$ |
| | $GB_2PP_1$ | 49.51±0.17$^{e}$ | 52.49±0.20$^{k,l}$ | 54.23±0.24$^{n}$ |
| a* | C | 17.42±0.21$^{e}$ | 18.69±0.14$^{h}$ | 19.37±0.19$^{j}$ |
| | C½ | 14.36±0.20$^{b}$ | 17.93±0.17$^{f}$ | 18.70±0.13$^{h}$ |
| | $GB_1$ | 15.84±0.15$^{c}$ | 16.82±0.18$^{d}$ | 17.72±0.19$^{e}$ |
| | $GB_2$ | 19.10±0.25$^{j}$ | 19.33±0.21$^{j}$ | 19.46±0.18$^{j}$ |
| | $PP_1$ | 15.89±0.22 | 18.58±0.19$^{g}$ | 19.16±0.27$^{j}$ |
| | $PP_2$ | 12.02±0.30$^{a}$ | 18.22±0.18$^{g,h}$ | 18.26±0.23$^{g}$ |
| | $GB_1PP_2$ | 15.70±0.29$^{c}$ | 19.12±0.25$^{j}$ | 20.10±0.22$^{k}$ |
| | $GB_2PP_1$ | 17.55±0.17$^{e}$ | 18.50±0.20$^{g,h}$ | 19.71±0.24$^{j}$ |
| b* | C | 7.19±0.18$^{b}$ | 7.67±0.16$^{c}$ | 7.91±0.24$^{c,d}$ |
| | C½ | 6.45±0.21$^{a}$ | 7.24±0.20$^{b}$ | 7.90±0.27$^{c,d}$ |
| | $GB_1$ | 8.27±0.12$^{d}$ | 8.93±0.13$^{f}$ | 10.73±0.26$^{j}$ |
| | $GB_2$ | 8.40±0.16$^{d,e}$ | 8.59±0.14$^{e}$ | 10.94±0.17$^{j}$ |
| | $PP_1$ | 7.41±0.17$^{b}$ | 8.16±0.20$^{d}$ | 9.28±0.11$^{g}$ |
| | $PP_2$ | 7.36±0.14$^{b}$ | 7.51±0.19$^{b,c}$ | 7.84±0.22$^{c,d}$ |
| | $GB_1PP_2$ | 8.50±0.23$^{e}$ | 9.45±0.25$^{g}$ | 11.73±0.27$^{k}$ |
| | $GB_2PP_1$ | 7.17±0.15$^{b}$ | 7.77±0.11$^{c}$ | 7.85±0.23$^{c,d}$ |

Means ± Standard deviations; $^{a, b, c, d, e, f, h, g, j, k}$: Different letters on the means denote statistical differences amongst samples ($p \leq 0.05$)

period of storage. On the 1st d of experiments the statistically significant ($p>0.05$) differences between b* values of samples $PP_1$ and C were not estimated. Similar results for the b* values of the samples of $PP_2$ on 6th d of experiments were observed (Table 3).

This means that only addition to the 1.00% GB in combination with 0.50% PP to the brain at the most significant degree contributes to develop of the similar color properties of cross-sectional surface view of cooked and smoked beef striploin with a ½ reduced content of sodium nitrite. The established positive influence of higher concentration of GB and lower concentration of PP on color properties of cooked and smoked beef striploin with a reduced content of sodium nitrite can be explain with the content of specific colorants, antioxidants and various carbohydrates of both studied drugs (Potterat, 2010; Yadav *et al*., 2010). The latter can serve as substrates for the development of lactic acid microflora during meat products' storage.

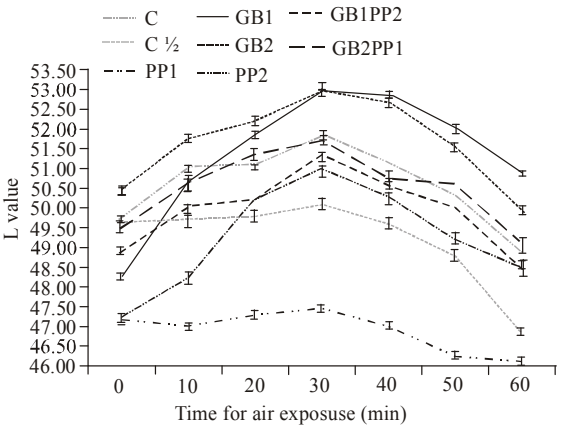


Fig. 1: Dynamics of the changes in the colour brightness (L* value) of the cured beef striploins surface cross-sectional views during the 60 min air exposure after 6 days storage at 0-4°C

**Dynamics of the changes of colour characteristics of the cross-sectional surface view of the cooked and smoked beef during of 60 min exposure on the air:** During the first 30 min of air exposure the L* values of all examined samples statistically significant ($p \leq 0.05$) increases, then to 60 min decreases and in most cases, reaching levels close to the initial was established (Fig. 1). In comparison with controls samples C, samples $GB_2PP_1$ have the similar L* values. Addition of GB only to brine (samples $GB_1$ and $GB_2$) enhances the lightness of the color and addition just a PP (samples $PP_1$ and $PP_2$), controls C½ with a reduced content of nitrite and samples $GB_1PP_2$ with a combination of a higher concentration of PP and a lower concentration of GB decreased L* values was determined (Fig. 1). During the 60 minute air exposure of all analyzed samples the red component of the color (a* value) decreases (Fig. 2) and the yellow component of the color (b* value) increases (Fig. 3) was found. Similar to the results obtained for the L* values, changes of the a* and b* values of samples $GB_2PP_1$ are closest to those of the control samples C (Fig. 2 and 3).

Faustman *et al*. (2010) supposed that colour changes directly related from oxidation processes. When the combination of red and orange substances was added similar colour changes than the controls

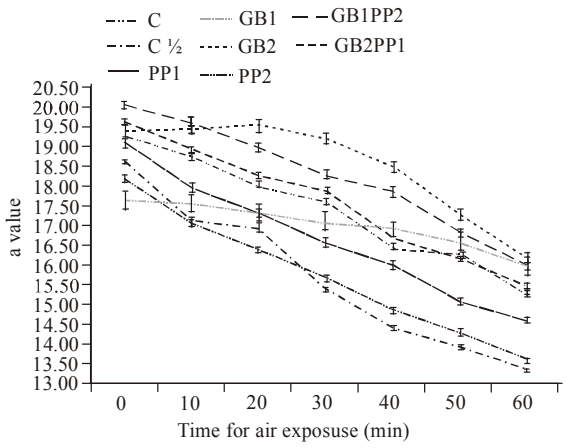


Fig. 2: Dynamics of the changes in the red component of the colour (a* value) of the cured beef striploins surface cross-sectional views during the 60 min air exposure after 6 days storage at 0-4°C

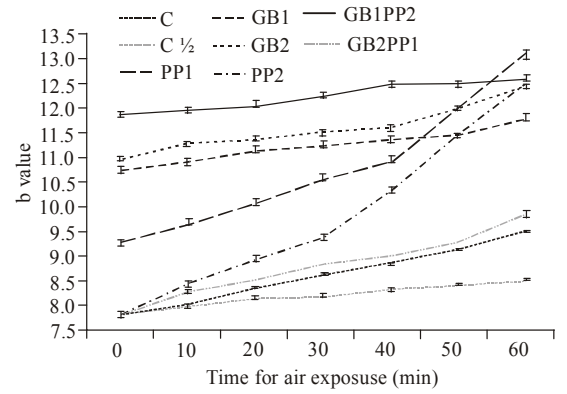


Fig. 3: Dynamics of the changes in the yellow component of the colour (b* value) of the cured beef striploins surface cross-sectional views during the 60 min air exposure after 6 days storage at 0-4°C

were found. Estévez *et al*. (2005) hypothesed the natural antioxidants successfully protected the heme molecule from degradation and significantly inhibited the increase of nonheme iron in refrigerated stored meat products.

**Changes of the technological properties:** On the first day of the experiment the contents of free amino nitrogen in the all experimental samples were statistically significant higher ($p \leq 0.05$) in comparisson with control samples C. During the refrigeration storage of all samples the content of free amino mitrogen statistically significant ($p \leq 0.05$) decresed. On the 6$^{th}$ d of storage the lowets levels were determined in control samples C (Table 4). Similar of us Lorenzo *et al*. (2008) were found the content of the different nitrogen fractions and of the free amino acids indicated that protein degradation during the dry-cured Spanish lacón was manufactured.

An increase of protein carbonyls in majority of samples during storage (0-4°C/6 d) was established. Exeptions were found at samples $GB_1PP_2$ and $GB_2PP_1$ only. In comparisson with control samples C, on 6$^{th}$ d of storage statisticaly significant ($p \leq 0.05$) reduction of total protein carbonyls at those both samples by 73% was determined (Table 4). Faustman *et al*. (2010) hypothesized that the lipid and protein oxidation are strongly related with release of iron from heme molecule and colour deterioration during refrigerated storage of meat products. According to our results, it can be expected that addition of combination between GB and PP at concentration 0.5 or 1.0% can be used for effective inhibition of protein oxidation in studied cooked and smoked beef fillets.

Hydrolytic changes in total lipids extracted from samples are set by the indicator acid value. A statistically significant ($p \leq 0.05$) increasing of acid values during the refrigeration storage of all samples was established. Both the 1$^{st}$ and the 6$^{th}$ days of the experiment the lowets AV levels were determined in samples $GB_1PP_2$ and $GB_1$, followed by levels in samples $GB_2$ and $PP_2$ (Table 4). An increase of the AV with 35%-on 1$^{st}$ d and 27%-on the 6$^{th}$ d was determined at those samples. Probably the GB contains factors inhibiting lipolysis (Potterat, 2010) which are amplified in combination with the addition of a 1.0% PP into the pikle. Thus, the findings allow us to conclude that addition of 0.5 to 1.0% GB in combination with a 1.0%

Table 4: Changes of the pH values, free amino nitrogen, total protein carbonyls, acid value and TBARS of the cured beef striploins

| | | Samples | C | C½ | $GB_1$ | $GB_2$ | $PP_1$ | $PP_2$ | $GB_1PP_2$ | $GB_2PP_1$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Day of | 1d | Detained brine, % | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| storage, d | 1d | Yield, % | 85 | 84 | 80 | 79 | 83 | 83 | 83 | 82 |
| | 1d | pH of pickle | 8.20±0.03$^{e}$ | 8.00±0.04$^{f}$ | 6.000±0.02$^{b}$ | 5.400±0.02$^{a}$ | 7.25±0.03$^{d}$ | 7.250±0.04$^{d}$ | 6.300±0.03$^{c}$ | 6.600±0.02$^{d}$ |
| | 1d | pH of | 6.60±0.01$^{d}$ | 6.50±0.02$^{c}$ | 6.300±0.01$^{a}$ | 6.300±0.02$^{a}$ | 6.40±0.01$^{b}$ | 6.400±0.01$^{b}$ | 6.300±0.01$^{a}$ | 6.300±0.02$^{a}$ |
| | 6d | muscle tissue | 6.70±0.03$^{e}$ | 6.60±0.04$^{d}$ | 6.600±0.02$^{d}$ | 6.500±0.01$^{c}$ | 6.55±0.04$^{c}$ | 6.630±0.03$^{d}$ | 6.480±0.05$^{c}$ | 6.500±0.05$^{c}$ |
| | 1d | Free amino nitrogen, | 6.55±0.20$^{a}$ | 7.85±0.15$^{c}$ | 7.270±0.21$^{b}$ | 7.350±0.11$^{b}$ | 7.12±0.20$^{b}$ | 7.740±0.16$^{c}$ | 7.120±0.13$^{b}$ | 7.740±0.14$^{c}$ |
| | 6d | mg/100g | 12.31±0.28$^{d}$ | 13.96±0.29$^{f}$ | 13.86±0.23$^{f}$ | 13.20±0.27$^{e}$ | 13.48±0.21$^{e,f}$ | 13.20±0.25$^{e}$ | 13.04±0.22$^{e}$ | 13.12±0.24$^{e}$ |
| | 1d | Protein carbonyls, | 0.68 ±0.19$^{a}$ | 1.630±0.21$^{c}$ | 1.560±0.23$^{c}$ | 1.120±0.16$^{b}$ | 1.93±0.23$^{d}$ | 1.850±0.19$^{d}$ | 0.610±0.11$^{a}$ | 0.710±0.10$^{a}$ |
| | 6d | nmol /mg proteins | 2.73±0.17$^{f}$ | 3.250±0.18$^{g}$ | 3.090±0.28$^{g}$ | 2.040±0.22$^{e}$ | 3.76±0.24$^{h}$ | 3.060±0.27$^{g}$ | 0.700±0.13$^{a}$ | 0.780±0.12$^{a}$ |
| | 1d | Acid value, | 0.81±0.09$^{b}$ | 0.870±0.10$^{b}$ | 0.500±0.08$^{a}$ | 0.590±0.07$^{a,b}$ | 0.82±0.09$^{b}$ | 0.600±0.08$^{a,b}$ | 0.450±0.07$^{a}$ | 0.700±0.08$^{b}$ |
| | 6d | mg KOH/g | 1.68±0.11$^{e}$ | 1.790±0.12$^{e}$ | 1.29 0±0.10$^{c}$ | 1.270±0.10$^{c}$ | 1.40±0.13$^{d}$ | 1.370±0.12$^{d}$ | 1.120±0.11$^{c}$ | 1.400±0.13$^{d}$ |
| | 1d | TBARS, | 0.97±0.02$^{b}$ | 0.950±0.06$^{b}$ | 1.000±0.07$^{b,c}$ | 0.890±0.02$^{a}$ | 0.86±0.04$^{a}$ | 0.930±0.05$^{a,b}$ | 1.530±0.09$^{f}$ | 1.110±0.04$^{d}$ |
| | 6d | mg MDA/ kg | 0.97±0.02$^{b}$ | 1.19 0±0.04$^{e}$ | 1.010±0.02$^{c}$ | 1.020±0.03$^{c}$ | 1.10±0.04$^{d}$ | 0.900±0.02$^{a}$ | 1.010±0.03$^{c}$ | 0.870±0.03$^{a}$ |

Means ± Standard deviations; $^{a, b, c, d, e, f, h, g, j, k}$: Different letters on the means denote statistical differences amongst samples ($p \leq 0.05$)

PP is effective to inhibit lipolytic changes in lipid fraction of cooked and smoked beef striploin.

Changes of the secondary products of lipid peroxidation in examined samples presented by TBARS were determined too (Table 4). Immediately after productions (1d) TBARS of samples $PP_1$, $GB_2$ and $PP_2$ are statistically significant ($p \leq 0.05$) lower with 7% comparing to the control samples C and C½. Contrary, the TBARS observed at samples $GB_1$, $GB_2PP_1$ and esspecialy in samples $GB_1PP_2$ are statistically significant ($p \leq 0.05$) higher in comparison with the control samples C and C½ with 4%, 14 and 37%, respectivelly. On 6$^{th}$ d of storage, one statistically significant ($p \leq 0.05$) decreasing of TBARS of samples $GB_2PP_1$- approx. with 22% was determined. The TBARS of samples $GB_2PP_1$ were not statistically significant ($p \leq 0.05$) different with those found in samples $PP_2$, followed by those in samples C which are with approximatly 9% higher. One comparison of TBARS on 1$^{st}$ and 6$^{th}$ d of refrigeration storage show no statistically significant ($p > 0.05$) changes of TBARS in samples $PP_2$ and C (Table 4). During the storage at 0-4ºC, was established decrease of TBARS at samples $GB_1PP_2$ and $GB_2PP_1$ ($p \leq 0.05$). The conclusion was made that the addition of combination of 1.0% GB and 0.5 or 1.0% PP along can effectively inhibite the lipid oxidation in cooked and smoked beef. Probably because of the higher antioxidant activity of GB (Potterat, 2010) synergistically enhanced by some components of the PP (Seo *et al*., 2005) this combination is more effective on lipid peroxidation inhibition in nitrite reduced cooked and smoked beef.

Initially established pH on the 1$^{st}$ and 6$^{th}$d of storage at 0-4ºC differ statistically significantly ($p \leq 0.05$) but in relatively short intervals between 0.30 and 0.22 at individual samples. A comparisson of the pH of samples on 6$^{th}$ d of storage shows slow but statistically significant ($p \leq 0.05$) increasing at all examined samples (Table 4). The smolest pH was determined in samples $GB_1$, $GB_2$, $GB_1PP_2$ and $GB_2PP_1$. The conclusion that the studied supplements had slight but statistically significant ($p > 0.05$) effect on pH of cooked and smoked beef striploin, indipendently of strong influence on pikle pH and yeld of the final product (Table 4).

## CONCLUSION

The results and their analysis allow us to conclude that alone use of dried goji berry (*Lycium chinense*) or powder of butternut pumpkin (*Cucurbita moschata*) leads to certain abnormalities in sensory quality and technological properties of cooked and smoked beef fillet. The addition to the pikle of a combination containing 1.0% GB and 0.5% PP guarantee the quality, sensory properties, colour characteristics and to prevent oxidative changes and allow to produce cooked and smoked beef striploin with a reduced amounts of nitrites.

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