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Possibility of extending shelf life of cevapcici

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ABSTRACT

The shelf life of cevapcici in which chemical additives were substituted with biopreservatives was examined. Bioprotective culture B-2 SafePro (Lactobacillus sakei) in freeze-dried form and the herb mixture, Oregano Plus, composed of oregano (Origanum vulgare L. ssp. Viridis) and savory (Satureja montana L.), were used. Three types of cevapcici were produced: with B-2 SafePro (control); with Oregano Plus, and; with both B-2 SafePro and Oregano Plus. pH, grilling weight loss, chemical composition, sensory characteristics, thibarbituric acid reductive substances (TBARS), and microbiological profile were investigated in all cevapcici treatments. The pH decreased in all treatments after 7 days' storage at 0–4 °C. Cevapcici with B-2 SafePro had a significantly ($P<0.05$) lower pH than the other two treatments after cold storage. A statistically significant negative correlation between pH and grilling weight loss of cevapcici was found ($P<0.01$). Consequently, the highest weight loss during grilling was found in cevapcici that contained B-2 SafePro. Products that contained both B-2 SafePro and Oregano Plus had the most acceptable sensory attributes three days after production. However, in cevapcici with B-2 SafePro (compared with the other two products), all sensory properties were significantly ($P<0.05$) better seven days after production. After frozen storage, significantly ($P<0.05$) lower TBA-numbers in the cevapcici with Oregano Plus indicate that this herb mixture has evident antioxidative effects. Products with B-2 SafePro had the highest total bacteria count, as a result of intensive growth and development the L. sakei. After 7 days' storage at 0–4 °C, the most expressive effect against Enterobacteriaceae was detected in cevapcici with Oregano Plus compared with the other two producs. Generally, it can be concluded that the addition of the oregano and savory mixture results in cevapcici that are microbiologically safe and have extended shelf life

1. Introduction

Consumer perception of meat products has changed in recent years, resulting in increased interest in healthier meat products (*Selani et al*., 2022). Consumer health care is oriented towards extending the shelf life and appropriate microbiological quality of meat and meat products. In response to this demand, there is a constant need to introduce new technologies in the food industry (*Jarmoluk et al.,* 2005).

Fresh meat products are typically sold at refrigerated temperatures (2–5 °C). However, various unwanted product changes, such as microbial growth and lipid oxidation, can occur during cooling, leading to reduced quality, meat spoilage, and financial losses (*Sallama & Samejima*, 2004).

Cevapcici are fast food products found traditionally in the countries of Southeast Europe. These meat products have been produced in the region since the Ottoman expansion over the Balkans. Today, they are considered a national dish of

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the Balkans, and are made from minced meat and various added spices. Cevapcici have a short shelf life of a maximum of 72 hours compared to meat in pieces. Storage of cevapcici, under aerobic conditions, enables growth of bacteria from the genus of *Pseudomonas* which causes changes in their texture, color, smell, and taste (*Gill*, 1986).

A recent trend in food production is to decrease synthetic additives, which have been vastly used because of the growing concern among consumers about their serious effects on human health (*Elzamzamy*, 2014). Consequently, the development and utilization of natural products with combined antioxidant and antibacterial activities in meat products could be essential and beneficial for extending their shelf life and reducing the risk of foodborne diseases (*Fernández-López et al*., 2004). Plant-derived compounds have been effective in reducing lipid oxidation in meat products (*Estévez et al.,* 2005). Many herbs, spices, and their extracts have been added to a variety of foods to improve their sensory characteristics and extend shelf life. Herbs belonging to the *Lamiaceae* family, primarily oregano (*Origanum vulgare* L.), rosemary (*Rosmarinus officinalis* L.), and sage (*Salvia officinalis* L.), have been identified as possessing significant antioxidant properties (*Velasco & Williams*, 2011) attributable to three mechanisms: free-radical scavenging activity, transition-metal-chelating activity, and/or singlet-oxygen-quenching capacity (*Castillo et al.,* 2013). Oregano is an aromatic perennial herb, with bioactive constituents, such as carvacrol and thymol, which possess several medicinal properties, namely antioxidant, antidiabetic, anti-inflammatory, antimicrobial, antiviral, antiparasitic, anti-neoplastic, and immune modulatory (*Alagawany et al*., 2020). *Origanum vulgare* L. ssp.Viridis is used to cure respiratory diseases (*Van Den Broucke & Lemli*, 1980), hypoglycemic disease (*Lemhardi et. al.,* 2004) and leukemia (*Goun et al*., 2002). *Satureja montana* L., commonly known as winter savory or mountain savory, also belongs to the *Lamiaceae* family and originates from the Mediterranean, but is widespread in Europe, Russia and Turkey. This highly aromatic herb has been traditionally used as a seasoning for food and an ingredient in teas for centuries (*Oliveira et al*., 2012). The high antimicrobial activity of savory can be attributed to major compounds, such as carvacrol, thymol, terpinen-4-ol and linalool (*Dorman & Deans,* 2000), and can be used to maintain meat quality, extend product shelf life, and prevent economic losses (*Yin & Cheng*, 2003).

Therefore, the purpose of the present investigation was to evaluate the possibility of extending the shelf life of cevapcici in which chemical additives were substituted with biopreservatives.

2. Materials and Methods

2.1 Production of cevapcici

Cevapcici were produced under industrial conditions, and the composition of the three products is given in Table 1. A mixture of reductive agents consisting of E300 (ascorbic acid), E316 (sodium erythorbate) and E330 (citric acid) was used. Bioprotective culture B-2 SafePro *(Lactobacillus sakei*) (Chr. Hansen, Denmark) in freeze-dried form and the herb mixture Oregano Plus (Alkaloid AD Skopje, R. N. Macedonia), composed of oregano (*Origanum vulgare* L.) and savory (*Satureja montana*), were used. In three replications, three treatments of cevapcici were produced: R\L with B-2 SafePro, R\O with Oregano Plus, and R\O\L with combined use of B-2 SafePro and Oregano Plus.

After production, the cevapcici were wrapped in cling film, placed in a cardboard box and stored at 0–4 °C .

2.2 Analytical methods

The pH of cevapcici was measured by a pH meter (pH-540 GLP, WTW, Germany).

The difference in weight (shrinkage) of cevapcici before and after grilling expressed as a percentage of cevapcici weight before grilling was defined as the weight loss of thermally processed cevapcici.

The degree of lipid oxidation in cevapcici was determined by TBARS test according to the method of Tarladgis et al. (1960), modified by Shahidi et al. (1983 and 1987). TBARS number was determined in grilled cevapcici (stored overnight in a refrigerator at a temperature of 0–4 °C).

The investigation of sensory characteristics was performed according to the score-pointing method (*Radovanović & Popov-Raljić*, 2000). The external appearance and color were assessed in fresh (raw, thermally unprocessed products), while the other sensory characteristics were assessed in grilled cevapcici.

Microbiological analyses of cevapcici were made according to the following methods: total number of aerobic bacteria ISO 4833:2013, *Listeria monocitogenes* ISO 11290-1, *Salmonella sp.* ISO 6579-1, *Campylobacter* ISO 10272-1, *Yersinia enterocolitica*

Table 1. Composition of cevapcici (%)

Ingredients	Treatments[1]		
	R\L	R\O	R\O\L
Beef (70% fresh and 30% frozen)	65	65	65
Chicken gut (frozen)	13	13	13
Textured soy	10	10	10
Fresh onion	8	8	8
Soy flour	4	4	4
Salt	1.8	1.8	1.8
Polyphosphates	0.3	0.3	0.3
Soy isolate	1	1	1
Ground black pepper	0.45	0.45	0.45
B-2 SafePro™	0.25	-	0.25
Oregano Plus	-	0.2	0.2

Legend: [1] Cevapcici treatments: R\L produced with B-2 SafePro; R\O produced with Oregano Plus and; R\O\L produced with combined use of B-2 SafePro and Oregano Plus

ISO 10273, *E. coli* O157:H7 ISO 16654 and *Enterobacteriaceae spp* ISO 21528:2017 (*Official Gazette of R. Macedonia*, 2018 and 2022).

Statistical evaluation of data obtained from the research was performed by variance analysis (ANOVA), using the statistical package SPSS.

3. Results and Discussion

The pH measurements of cevapcici at three and seven days after production are presented in Table 2. There was a pH decrease in all treatments. R\L cevapcici had significantly ($P < 0.05$) lower pH at three or seven days after production than the other two treatments. Between R\O and R\O\L products, the differences in pH were statistically insignificant. The presence of the lactic acid bacterium *L. sakei* in R\L products caused significantly more acidification compared to the other cevapcici types. It is assumed that the higher pH in R\O\L products was due to the inhibitory effect of the phenolic components of the herbs on the lactic acid bacteria.

The pH values obtained in the present research were in accordance with the literature data. According to *Jelle* (1991), in B-2 SafePro products, carbohydrates are converted to lactic acid, resulting in a significant decrease in pH. *Jałosińska & Wilczak* (2009) reported that the addition of various plant extracts at 0.2% to meatball products resulted in little change in product acidity. On the 8th day of storage, pH reached 6.05 in meatballs with rosemary and 6.08 in meatballs with lovage (*Jałosińska & Wilczak*, 2009). According

Table 2. pH of cevapcici, three and seven days after production

Time (days)	Treatments[1]								
	R\L			R\O			R\O\L		
	M	S	C	M	S	C	M	S	C
pH_3	6.05^a	0.10	0.01	6.13^b	0.03	0.01	6.12^b	0.30	0.01
pH_7	5.78^a	0.10	0.02	6.02^b	0.11	0.02	6.02^b	0.08	0.01

Legend: [1] Cevapcici treatments: R\L produced with B-2 SafePro, R\O produced with Oregano Plus and, R\O\L produced with combined use of B-2 SafePro and Oregano Plus; [a, b] Means in rows with different superscripts are significantly different ($P < 0.05$); M = mean, S = standard deviation, C = coefficient of variation

to *Verplaetse* (1994) and *Molly et al.* (1997), acidification of meat products, which occurs as a result of the proliferation of lactic acid bacteria, has many positive effects: reduction of the pH; ensuring hygienic stability; obtaining a characteristic sour taste; coagulation of proteins in meat; reduction of water holding capacity, and; development of a desirable red colour by favoring the reaction between nitrogen monoxide and myoglobin.

A statistically significant negative correlation ($R = -0.357$) between the cevapcici's pH and grilling weight loss was found ($P < 0.01$). Consequently, the highest weight loss during grilling was found in R\L cevapcici (Table 3). They were significantly ($P < 0.05$) different from the other two groups of cevapcici produced. The results obtained correspond to those of Kraft (1992), according to which weight loss during heat treatment increases with decreasing pH value.

From Table 4, it can be seen that TBARS values of cevapcici were low (< 0.60) seven days after storage (0–4 °C), but after 90 days' frozen storage (−18 °C) were higher (> 0.80) in R\L and R\O\L treatments. Significantly ($P < 0.05$) lower TBA numbers in R\O products than in the other two products after the frozen storage indicate that the herb mixture Oregano Plus has an evident antioxidative effect. In other studies, reduction of meat oxidation during refrigeration was obtained by adding oregano and sage essential oils to beef meat (*Fasseas et al.,* 2008) or even spraying a rosemary and vitamin C solution onto the surface (*Djenane et al.,* 2003). In addition, incorporation of oregano, rosemary, and sage essential oils into meats can delay lipid oxidation during refrigerated and frozen storage (*Velasco & Williams*, 2011).

Table 5 presents the results of the sensory analysis of cevapcici three and seven days after their production. Besides the average grades given by panelists, adjusted averages are presented. It is known that ordinary average grades are not a real indicator of the general quality of the product, because the characteristics evaluated are not equal in importance for the total quality, so correction (C) using appropriate coefficients of importance (CI) was required. Taste and smell , without doubt, have a significant share in the overall assessment.

It is noticeable that three days after production, R\O\L products had the most acceptable sensory attributes among the cevapcici groups, except for the external appearance which was most acceptable in R\L cevapcici. The pointed mean value and the percentage of maximum possible quality were higher in R\O\L cevapcici than in the other cevapcici

Table 3. Grilling weight loss of cevapcici, three and seven days after production (%)

Time (days)	Treatments[1]								
	R\L			R\O			R\O\L		
	M	S	C	M	S	C	M	S	C
3 days after production	15.20[a]	2.49	0.16	13.16[b]	2.91	0.22	14.91[b]	3.10	0.21
7 days after production	17.10[a]	2.80	0.17	15.18[b]	2.96	0.19	15.35[b]	1.83	0.12

Legend: [1] Cevapcici treatments: R\L produced with B-2 SafePro, R\O produced with Oregano Plus and, R\O\L produced with combined use of B-2 SafePro and Oregano Plus; [a, b] Means in rows with different superscripts are significantly different ($P < 0.05$); M = mean, S = standard deviation, C = coefficient of variation

Table 4. Average TBARS (mgMDA/kg product) values of cevapcici, 7 and 90 days after production

Time (days)	Treatments[1]								
	R\L			R\O			R\O\L		
	M	S	C	M	S	C	M	S	C
7 days after production	0.52[a]	0.23	0.44	0.41[a]	0.18	0.44	0.47[a]	0.18	0.38
90 days after production	0.87[a]	0.09	0.10	0.51[b]	0.01	0.02	0.96[a]	0.04	0.04

Legend: [1] Cevapcici treatments: R\L produced with B-2 SafePro, R\O produced with Oregano Plus and, R\O\L produced with combined use of B-2 SafePro and Oregano Plus; [a, b] Means in rows with different superscripts are significantly different ($P < 0.05$); M = mean; S = standard deviation; C = coefficient of variation

Table 5. Sensory evaluation of cevapcici, three and seven days after production

Sensory characteristics	CI	Treatments[1]											
		3 days after production						7 days after production					
		R\L		R\O		R\O\L		R\L		R\O		R\O\L	
		S	C	S	C	S	C	S	C	S	C	S	C
External appearance	**1**	4.0	4.0	3.8	3.8	3.9	3.9	4.5	4.5	3.5	3.5	4.0	4.0
Cross section appearance	**4**	4.2	16.8	4.1	16.4	4.4	17.6	4.3	17.2	3.9	15.6	3.8	15.2
Texture	**3**	4.2	12.6	3.9	11.7	4.5	13.5	4.6	13.8	4.3	12.9	3.9	11.7
Colour	**3**	3.9	11.7	3.7	11.1	4.1	12.3	4.5	13.5	3.8	11.4	4.0	12
Smell	**4**	4.3	17.2	4.1	16.4	4.4	17.6	4.6	18.4	4.1	16.4	3.7	14.8
Taste	**5**	4.1	20.5	4.2	21	4.3	21.5	4.5	22.5	4.3	21.5	3.7	18.5
Total CI	**20**												
Pointed mean value			4.14		4.02		4.32		4.49		4.06		3.81
% of maximum possible quality			82.8		80.4		86.4		89.9		81.3		76.2

Legend: [1] Cevapcici treatments: R\L produced with B-2 SafePro, R\O produced with Oregano Plus and, R\O\L produced with combined use of B-2 SafePro and Oregano Plus; CI = Coefficient of importance; S = Score; C = Corrected score

groups at three days post-production. However, at seven days after production, all sensory properties were better in R\L cevapcici than in the other two cevapcici groups.

The results presented in Table 6 indicate that three days after production, the R\O\L and R\L cevapcici had significantly ($P < 0.05$) better texture compared to R\O products. For the other sensory attributes, the differences between treatments were statistically insignificant.

Seven days after production (Table 7), a significant ($P<0.05$) difference between the groups was recorded in all the tested sensory properties, except for the cross-section appearance. Cevapcici with B-2 SafePro had higher scores of all investigated sensory characteristics than did the other two cevapcici groups. The texture, smell, and taste were also highly rated for the cevapcici with a mixture of oregano and savory, but their external appearance and colour were unsatisfactory.

Table 6. Comparative overview of basic statistical parameters of sensory properties of cevapcici, three days after production

Sensory characteristics	Treatments[1]								
	R\L			R\O			R\O\L		
	M	S	C	M	S	C	M	S	C
External appearance	4.00[a]	0.97	0.24	3.78[a]	0.95	0.25	3.95[a]	0.91	0.23
Cross section appearance	4.22[a]	0.75	0.17	4.08[a]	0.72	0.18	4.38[a]	0.64	0.15
Texture	4.22[a]	0.85	0.2	3.92[b]	0.89	0.23	4.49[a]	0.65	0.14
Colour	3.95[a]	0.91	0.23	3.7[a]	0.88	0.24	4.11[a]	0.13	0.03
Smell	4.27[a]	0.73	0.17	4.08[a]	1.01	0.25	4.38[a]	0.72	0.16
Taste	4.11[a]	0.73	0.18	4.16[a]	0.9	0.22	4.32[a]	0.67	0.15

Legend: [1] Cevapcici treatments: R\L produced with B-2 SafePro, R\O produced with Oregano Plus and, R\O\L produced with combined use of B-2 SafePro and Oregano Plus; [a, b] Means in rows with different superscripts are significantly different ($P < 0.05$); M = mean; S = standard deviation; C = coefficient of variation

Table 7. Comparative overview of basic statistical parameters of sensory properties of cevapcici, seven days after production

Sensory characteristics	Treatments								
	R\L			R\O			R\O\L		
	M	S	C	M	S	C	M	S	C
External appearance	4.55[a]	0.56	0.12	3.52[b]	0.87	0.25	4.00[b]	0.71	0.18
Cross section appearance	4.30[a]	0.69	0.16	3.94[a]	0.86	0.22	3.79[a]	0.92	0.24
Texture	4.61[a]	0.56	0.12	4.27[ab]	0.72	0.17	3.91[b]	0.92	0.24
Colour	4.48[a]	0.67	0.15	3.79[b]	0.96	0.25	4.03[ab]	0.73	0.18
Smell	4.58[a]	0.56	0.12	4.06[ab]	1.03	0.25	3.70[b]	1.07	0.29
Taste	4.52[a]	0.75	0.16	4.33[a]	0.78	0.18	3.70[b]	0.18	0.05

Legend: [1] Cevapcici treatments: R\L produced with B-2 SafePro, R\O produced with Oregano Plus and, R\O\L produced with combined use of B-2 SafePro and Oregano Plus; [a, b] Means in rows with different superscripts are significantly different ($P < 0.05$); M = mean, S = standard deviation; C = coefficient of variation

The addition of bioprotective cultures in shaped minced meat products creates a chain of reactions that cause desirable changes in the products' sensory characteristics (*Verplaetse, 1994*). A stable colour and desired texture and flavour were obtained in hamburgers with a bioprotective culture (*Erkes,* 2011). *Jaspal et al.* (2021) found that oregano oil at a level of more than 0.2% (w/w) negatively affects the colour and sensory properties of chicken meat. The application of 1% oregano essential oil increased lightness and hue and decreased redness, whereas 0.5% of the oil did not affect pork color (*Zduńczyk et al., 2023*).

Efenberger-Szmechtyk et al. (2021) pointed out that herbs and spices used as additives in food products to enhance their aroma and taste can also be good solutions for preservation and extension of the products' shelf life. This is due to polyphenols and other bioactive compounds in herbs that have antioxidant and antimicrobial characteristics.

Microbiological analyses of the tested cevapcici (Table 8) showed that pathogenic bacteria were not detected in any treatment. The total number of aerobic mesophilic bacteria at one and seven days after production was highest in R/L products (compared

Table 8. Presence of pathogenic bacteria, and the number of Enterobacteriaceae and total aerobic mesophilic bacteria, one and seven days after production

Bacteria	Treatments[1]					
	R\L		R\O		R\O\L	
	1 day	7 days	1 day	7 days	1 day	7 days
Campylobacter	-	-	-	-	-	-
Yersinia enterocolitica	-	-	-	-	-	-
Salmonella spp.	-	-	-	-	-	-
Listeria monocytogenes	-	-	-	-	-	-
E. coli O157:H7	-	-	-	-	-	-
Enterobacteriaceae spp.	4.50 log cfu/g	4.47 log cfu/g	4.36 log cfu/g	4.31 log cfu/g	4.30 log cfu/g	4.81 log cfu/g
Total aerobic mesophilic bacteria	5.30 log cfu/g	5.50 log cfu/g	4.84 log cfu/g	5.20 log cfu/g	4.30 log cfu/g	4.30 log cfu/g

Legend: [1] Cevapcici treatments: R\L produced with B-2 SafePro, R\O produced with Oregano Plus and; R\O\L produced with combined use of B-2 SafePro and Oregano Plus – Not detected

with the other two cevapcici groups) as a result of the *L. sakei* colony intensive growth and development. The most expressive anticoliform effect was detected in R\O products compared with the other two cevapcici products.

The antimicrobial activity of herbs and spices is a result of the interaction between specific biochemical components in the herbs/spices and the metabolic mechanisms inside the bacteria cells. Therefore, these biochemical components need to enter inside the cell to influence its function (*Vergara et al.,* 2020). The present results were in accordance with those found by *Zhou et al*. (2023), who studied the effects of natural plant extracts on meat product quality. According to those authors, reduction of the number of total aerobic mesophilic bacteria is probably the result of reduced pH caused by the activity of bioprotective cultures and the antibacterial effect of the spice mixture. According to *Burt* (2004) oregano has a suppressive effect on the growth and development of *Listeria monocytogenes, Salmonella* spp*., E. coli* O157:H7*, Bacillus cereus* and *Staphylococcus aureus* in meat products. Oregano essential oil (0.5% and 1%) could delay the growth of microorganisms and decrease the final counts of the spoilage microorganisms (*Skandamis & Nychas, 2001*).

4. Conclusion

Generally, it can be concluded that the addition of a mixture of oregano and savory results in products that are microbiologically safe and have an extended shelf life. A negative correlation (P<0.01) was found between pH and cooking loss that occurred on grilling the cevapcici. This means that decreasing the pH significantly (P<0.01) increases the cooking loss during cevapcici grilling. Lipid oxidation is almost completely prevented in products with Oregano Plus. Among the treatments, 90 days after production, a significantly (P<0.05) higher TBK number was recorded in cevapcici with Oregano Plus. Seven days after production, sensory evaluation showed products with the B-2 SafePro bioprotective culture were the best overall among the three cevapcici groups. The presence of pathogenic bacteria was not detected in any group of cevapcici. The total number of aerobic mesophilic bacteria is highest in products with bioprotective culture. This is due to the intensive growth and development of the lactic acid bacterium, *L. sakei*. In order to reduce the growth of *Enterobacteriaceae* in cevapcici during cold storage, the mixture of oregano and savory could be effective.

Mogućnost produženja roka trajanja ćevapčića

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INFORMACIJE O RADU

Ključne reči:
Ćevapčići
Origano
Vrijesak
Proizvodi od mesa
Rok trajanja

APSTRAKT

Ispitan je rok trajanja ćevapčića u kojima su hemijski aditivi zamenjeni biokonzervansima. Korišćena je biozaštitna kultura B-2 SafePro (Lactobacillus sakei) u liofilizovanom obliku i biljna smeša Origano Plus, sastavljena od origana (Origanum vulgare L. ssp. Viridis) i vrijeska (Satureja montana L.). Proizvedene su tri vrste ćevapčića: sa B-2 SafePro (kontrola); sa Origano Plus; i sa B-2 SafePro i Origano Plus. U svim tretmanima ćevapčića ispitivani su pH, gubitak mase na roštilju, hemijski sastav, senzorne karakteristike, reaktivne supstance tiobarbiturnekiseline (TBARS) i mikrobiološki profil. Vrednost pH se smanjila u svim tretmanima nakon 7 dana skladištenja na 0–4 °C. Ćevapčići sa B-2 SafePro su imali značajno (P<0,05) niži pH u odnosu na druga dva tretmana nakon skladištenja na hladnom. Utvrđena je statistički značajna negativna korelacija između pH vrednosti i gubitka mase ćevapčića na roštilju (P<0,01). Shodno tome, najveći gubitak mase tokom pečenja je zabeležen kod ćevapčića koji su sadržali B-2 SafePro. Proizvodi koji su sadržali i B-2 SafePro i Origano Plus imali su najprihvatljivije senzorne atribute tri dana nakon proizvodnje. Međutim, kod ćevapčića sa B-2 SafePro (u poređenju sa druga dva proizvoda) sve senzorne karakteristike su bile značajno bolje (P<0,05) sedam dana nakon proizvodnje. Nakon zamrznutog skladištenja, značajno (P<0,05) niži TBA-brojevi u ćevapčićima sa Origano Plusom ukazuju na to da ova biljna smeša ima evidentno antioksidativno dejstvo. Proizvodi sa B-2 SafePro su imali najveći ukupan broj bakterija, kao rezultat intenzivnog rasta i razvoja L. sakei.

Posle 7 dana skladištenja na 0–4 , najizrazitiji efekat protiv Enterobacteriaceae je otkriven kod ćevapčića sa Origano Plus u poređenju sa druga dva proizvoda. Uopšteno gledano, može se zaključiti da se dodavanjem mešavine origana i vrijeska dobijaju ćevapčići koji su mikrobiološki bezbedni i imaju produženi rok trajanja.

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