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The Effect of Adding Black Chokeberry Pomace on the Physicochemical, Organoleptic, and Microbiological Quality Attributes of Beef Burgers

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INTRODUCTION & AIM

Managing waste products generated in the food industry is a pertinent topic in food science. Research in this area is driven by the increasing concern for the natural environment and the desire to create an ideal model of sustainable production and consumption. One of the by-products that is already used in the production of various food products is fruit pomace. In Central and Eastern Europe, the attention of scientists is drawn to pomace from black chokeberry (*Aronia melanocarpa*) due to the large production of chokeberries and the high content of bioactive substances in its berries. Little information was found in the available literature regarding the application possibilities of raw, i.e. slightly processed (e.g. shredded), fruit pomace in comminuted meat products. The subject of previous studies was most often the use of dried pomace or extracts obtained from it in meat processing.

The study aimed to assess the effect of adding shredded black chokeberry (*Aronia melanocarpa*) pomace in amounts of 0.0%, 0.5%, 1.0%, 2.0%, and 3.0% on the quality of beef burgers subjected to heat treatment and stored in vacuum packaging at refrigeration (+4°C) for 14 days.

METHOD

The beef forequarter trimmings and beef tallow used for burger production were purchased from a meat processing plant. Black chokeberry (*Aronia melanocarpa* (Michx.) Elliott), specifically of the Galicjanka variety, was used to produce pomace. The berries were washed and then pressed using a laboratory hydraulic press. Afterwards, the pomace was treated with an enzymatic preparation that does not degrade anthocyanins. The pomace was vacuum-packed and stored at –60 °C ± 1°C. On the day of burger production, the pomace was thawed in a microwave oven and ground to a paste consistency.

The production of beef burgers started with grinding beef and beef tallow. The ground materials were then mixed in a ratio of 80:20 with a laboratory mixer. **Five burger variants were prepared: BC, B0.5, B1, B2, and B3. These variants contained differing amounts of chokeberry pomace: 0%, 0.5%, 1.0%, 2.0%, and 3.0%, respectively**. Additionally, all burgers included 1.5% table salt.

The subsequent stages of the beef burger production process included mixing the ingredients in a laboratory mixer, shaping the burgers with a manual mould, baking them in a convection-steam oven, cooling, vacuum packaging, and storing them at a refrigerated temperature.

On the day of production, the thermal loss, change in diameter ("shrinkage"), and the content of basic chemical components were determined in the burgers differing in the addition level of chokeberry pomace. During the storage of the burgers – on the days 1, 7, and 14 – pH, shear force, and colour parameters *L**, *a**, and *b** were measured; an organoleptic assessment was conducted, and an evaluation of microbiological quality (aerobic mesophilic microorganisms, psychrotrophic bacteria, lactic acid bacteria, *Enterobacteriaceae*, *Escherichia coli*) was performed.

Figure 1. From the left: hydraulic press for pressing fruit, shredded black chokeberry pomace, beef burgers with different amounts of added black chokeberry pomace [own photo].

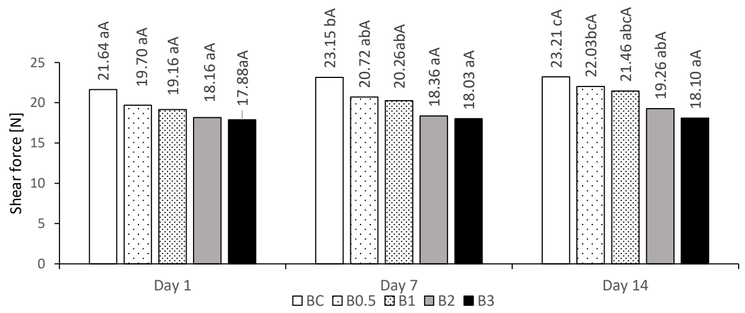
Table 1. Thermal loss (n=6), shrinkage (n=6), and the content of selected chemical components (n=4) in beef burgers.

Feature	BC	B0.5	B1	B2	B3
Thermal loss [%]	29.9 ^{a}	31.4 ^{ab}	31.7 ^{b}	32.8 ^{b}	35.3 ^{c}
Shrinkage [%]	20.6 ^{a}	21.2 ^{ab}	21.6 ^{ab}	22.6 ^{bc}	23.5 ^{c}
Water content [%]	57.06 ^{a}	54.75 ^{a}	54.16 ^{a}	54.66 ^{a}	54.50 ^{a}
Protein content [%]	24.20 ^{a}	24.47 ^{a}	25.48 ^{a}	25.42 ^{a}	25.89 ^{a}
Fat content [%]	16.15 ^{b}	10.01 ^{b}	15.89 ^{b}	14.96 ^{a}	14.67 ^{a}

a–d – mean values (in the same row) marked with different letters differ significantly ($p < 0.05$)

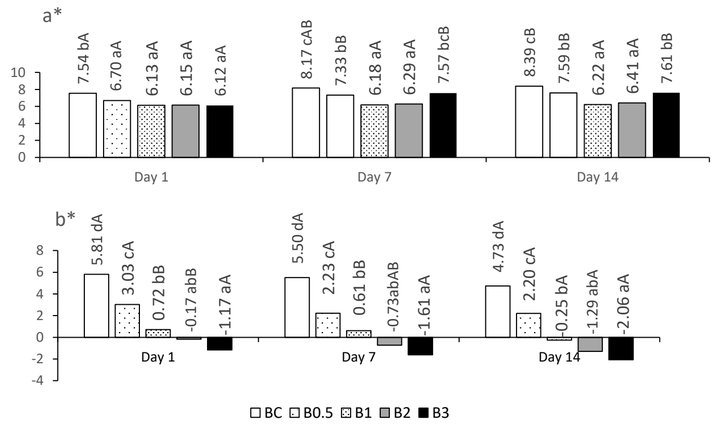
Figure 2. The effect of adding black chokeberry pomace on the shear force of beef burgers during storage.

a–d – mean values marked with different letters differ significantly ($p < 0.05$) between burger treatments on a given day of storage; A–B – mean values of a given burger treatment (for the same bar pattern) marked with different letters differ significantly ($p < 0.05$) between storage days.



RESULTS & DISCUSSION

Figure 3. The effect of adding black chokeberry pomace on the color parameters a* and b* of beef burgers during storage.



a–d – mean values marked with different letters differ significantly ($p < 0.05$) between burger treatments on a given day of storage; A–B – mean values of a given burger treatment (for the same bar pattern) marked with different letters differ significantly ($p < 0.05$) between storage days

Table 2. Results of the organoleptic evaluation (n=20) of beef burgers with varying amounts of black chokeberry pomace added during storage.

Storage time [d]	BC	B0.5	B1	B2	B3
	Appearance and color				
1	4.9 ^{bA}	4.8 ^{bA}	4.7 ^{bA}	3.9 ^{aA}	3.6 ^{aA}
7	4.8 ^{bA}	4.7 ^{bA}	4.6 ^{bA}	3.9 ^{aA}	3.6 ^{aA}
14	4.8 ^{bA}	4.7 ^{bA}	4.4 ^{bA}	3.7 ^{aA}	3.3 ^{aA}
	Aroma				
1	4.9 ^{bA}	4.8 ^{bA}	4.7 ^{abA}	4.6 ^{abA}	4.4 ^{aA}
7	4.8 ^{bA}	4.7 ^{abA}	4.6 ^{abA}	4.6 ^{abA}	4.3 ^{aA}
14	4.8 ^{bA}	4.7 ^{bA}	4.6 ^{abA}	4.5 ^{abA}	4.2 ^{aA}
	Taste				
1	4.9 ^{bA}	4.9 ^{bA}	4.4 ^{abA}	4.2 ^{aA}	4.0 ^{aA}
7	4.9 ^{bA}	4.8 ^{bA}	4.3 ^{aA}	4.1 ^{aA}	3.9 ^{aA}
14	4.9 ^{cA}	4.8 ^{cA}	4.3 ^{bA}	4.0 ^{aA}	3.8 ^{aA}
	Texture				
1	4.9 ^{cA}	4.9 ^{cA}	4.5 ^{bcA}	4.2 ^{abA}	3.9 ^{aA}
7	4.9 ^{cA}	4.9 ^{cA}	4.4 ^{bA}	4.1 ^{abA}	3.8 ^{aA}
14	4.9 ^{cA}	4.9 ^{cA}	4.4 ^{bA}	4.0 ^{aA}	3.8 ^{aA}

Table 3. Changes in the microbiological quality (n=4) of beef burgers with varying amounts of black chokeberry pomace added during storage.

Storage time [d]	BC	B0.5	B1	B2	B3
	Total Count of Aerobic Mesophilic Microorganisms [cfu/g]				
1	2.3×10^{1} ^{aA}	2.0×10^{1} ^{aA}	1.8×10^{2} ^{bA}	1.0×10^{1} ^{aA}	nd in 0,1g ^{aA}
7	5.3×10^{2} ^{bA}	2.0×10^{2} ^{aA}	2.3×10^{2} ^{aA}	8.8×10^{2} ^{cB}	5.9×10^{1} ^{aA}
14	1.8×10^{4} ^{eB}	1.0×10^{4} ^{dB}	1.1×10^{3} ^{aB}	3.5×10^{3} ^{bC}	5.6 v 10^{3} ^{cB}
	Psychotropic Bacteria [cfu/g]				
1	9.4×10^{2} ^{bA}	7.8×10^{1} ^{aA}	1.8×10^{2} ^{aA}	3.1×10^{1} ^{aA}	nd in 0,1g ^{aA}
7	1.2×10^{3} ^{cAB}	9.3×10^{1} ^{abA}	2.1×10^{2} ^{abA}	2.5×10^{2} ^{bB}	3.6×10^{1} ^{aA}
14	1.4×10^{3} ^{cB}	1.0×10^{3} ^{bB}	2.4×10^{3} ^{dB}	4.0×10^{2} ^{aB}	3.2×10^{2} ^{aB}
	Lactic Acid Bacteria [cfu/g]				
1	1.3×10^{2} ^{cA}	1.4×10^{2} ^{bcA}	1.1×10^{2} ^{cA}	3.0×10^{1} ^{aA}	4.7×10^{1} ^{abA}
7	1.5×10^{2} ^{bA}	2.1×10^{2} ^{cA}	1.6×10^{2} ^{bcA}	4.7×10^{1} ^{aA}	5.3×10^{1} ^{aA}
14	1.3×10^{3} ^{bB}	2.2×10^{3} ^{cB}	2.4×10^{3} ^{cB}	4.6×10^{1} ^{aA}	3.3×10^{2} ^{aB}
	Enterobacteriaceae family [cfu/g] – not detected in any of the burgers during storage				
	E. coli [cfu/g] – not detected in any of the burgers during storage				

a–d – mean values (in the same row) marked with different letters differ significantly ($p < 0.05$) between burger treatments on a given day of storage; A–B – mean values of a given burger treatment (in the same column) marked with different letters differ significantly ($p < 0.05$) between storage days.

Tables & Figures legend: BC – beef burgers without chokeberry pomace; B0.5 – beef burgers with 0.5% chokeberry pomace; B1 – beef burgers with 1.0% chokeberry pomace; B2 – beef burgers with 2.0% chokeberry pomace; B3 – beef burgers with 3.0% chokeberry pomace

CONCLUSION

It was found that using chokeberry pomace as an ingredient in beef burgers does not cause technological difficulties, but it does affect the quality of the product. With the increase in pomace addition, a significant ($p < 0.05$) rise in thermal loss, greater shrinkage, increased fat content, and a decrease in the pH of the burgers were observed. The addition of chokeberry pomace also resulted in a gradual decrease in the shear force of the burgers. Compared to the control product (without pomace), burgers with chokeberry pomace were characterised by a significantly ($p < 0.05$) darker colour, less redness, and less yellowness. In the organoleptic evaluation of all attributes, burgers produced with a lower addition of chokeberry pomace, i.e. 0.5% and 1.0%, received scores similar to the control product.
The addition of chokeberry pomace did not cause a deterioration in the microbial quality of the beef burgers.

The amount of chokeberry pomace added to the beef burger, with the raw material composition adopted in the study, could be 1.0% without negatively affecting the quality of the product.

A limitation of this work is that raw fruit pomace is a perishable raw material and should be used as quickly as possible. However, convenience food products with modified recipe compositions, similar to those adopted in this study, could be offered by local producers and catering establishments.