EFFECT OF FERMENTED RED BEET EXTRACTS ON QUALITY CHARACTERISTICS OF LOW-SALT SAUSAGE DURING REFRIGERATED STORAGE

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Abstract – The effect of fermented red beet and ascorbic acid on shelf stability of low-salt sausages stored for 4 weeks was investigated. The pH, color, TPA, and sensory characteristics of low-salt sausages were analyzed. The pH, lightness, yellowness, hardness, gumminess, and chewiness of sausages were decreased when the levels of fermented red beet were increased, whereas the redness of sausages was increased with increasing levels of fermented red beet. The redness of all treatments were decreased with increasing period of refrigeration storage. The appearance, color, and juiciness scores of control and all treatments were decreased with increasing period of refrigeration storage. The overall acceptability scores were also decreased with increasing fermented red beet levels. These results demonstrated that fermented red beet could be added to low-salt sausages to maintain their qualities of refrigerated storage.

Key Words – fermented red beet, low-salt, sausage.

I. INTRODUCTION

Low-salt sausages usually have short shelf life due to microoganisms. Meat products during storage might have degradation in color pigments, lipids, and proteins that can contribute to deterioration in flavor, texture, color, and nutritional value [1]. Vegetables contain significant amounts of natural antioxidants. Red beet (*Beta vulgaris* L.) is primarily cultivated for its roots that have high nutritional values [2]. Red beet roots are usually consumed after processing [3]. Red beet has been used in food technology as sources of antioxidants. It has been reported that the benefits of antioxidants from red beet are generally accepted by consumers. However, in that study, only red beet extracts were assessed for their antioxidant activities in meat products. Therefore, the objective of this study was to determine the effect of fermented red beet on quality characteristics of low-salt sausages stored for 4 weeks.

II. MATERIALS AND METHODS

Five different groups of sausages were produced. The first group of sausages (NaCl 1.5%) served as controls. They were prepared without adding antioxidants. The remaining four groups (NaCl 1.0%) were prepared with the following: T1, 0.05% ascorbic acid; T2, 1.0% fermented red beet; T3, 3.0% fermented red beet; T4, 5.0% fermented red beet. Lean materials were homogenized and ground for 1 min 30 sec in a silent cutter. Pork back fat, NaCl, and sodium tripolyphosphate (0.15%) were added to the meat and mixed. After batter preparation, the meat batter was stuffed into collagen casings. Meat batters were dried at 45°C for 30 min, heated at 80°C for 60 min in a chamber, and cooled at 21°C for 3 h. To evaluate the pH, color, TPA, and sensory evaluation were examined during refrigerated storage.

III. RESULTS AND DISCUSSION

The pH values (initial and after 4 weeks of storage) of T1 (with ascorbic acid added) were lower ($p<0.05$) than those of other treatments. The pH values of sausages were decreased when the levels of fermented red beet were increased. This might be due to red beet fermentation by micro-ogranisms.

Table 1 Changes in pH of sausages formulations with fermented red beet during refrigerated storage

	Storage period (week)				
	0	1	2	3	4
Control	6.34^{aC}	6.35^{aC}	6.39^{aB}	6.51^{aA}	6.28^{aD}
T1	5.68^{bB}	6.01^{cA}	6.06^{cA}	6.08^{cA}	5.22^{eC}
T2	6.33^{aB}	6.34^{aB}	6.37^{aB}	6.49^{aA}	5.41^{dC}
T3	6.30^{aAB}	6.26^{bB}	6.35^{bA}	6.38^{bB}	5.78^{cC}
T4	6.29^{aA}	6.24^{bA}	6.32^{bA}	6.37^{bA}	6.02^{bB}

All values are mean ± SD of the three replicates.

$^{a-e}$ Means sharing different letters in the same column are significantly different (p<0.05).

$^{A-D}$ Means sharing different letters in the same row are significantly different (p<0.05).

Control: sausage with 1.5% NaCl, T1: sausage with 1.0% NaCl + 0.05% ascorbic acid, T2: sausage with 1.0% NaCl + 1.0% fermented red beet, T3: sausage with 1.0% NaCl + 3.0% fermented red beet, T4: sausage with 1.0% NaCl + 5.0% fermented red beet.

The color values of low-salt sausages might have been influenced by fermented red beet because treatments with higher fermented red beet showed lower lightness and yellowness values but higher redness values. The lightness and yellowness values of all treatments were decreased with increasing refrigerated storage, whereas the redness values were increased with increased refrigerated storage.

Table 2 Changes in color of sausages formulations with fermented red beet during refrigerated storage

Color parameters		Storage period (week)				
		0	1	2	3	4
L	Control	73.24^{aA}	72.79^{aB}	72.58^{aB}	71.93^{aC}	71.27^{aD}
	T1	72.51^{bA}	71.40^{bB}	71.32^{bB}	71.18^{bC}	70.07^{bD}
	T2	70.98^{cA}	70.93^{cA}	70.22^{cB}	70.02^{cB}	69.91^{cC}
	T3	70.30^{dA}	70.25^{dA}	70.24^{cA}	69.50^{dB}	67.53^{dC}
	T4	68.91^{eA}	68.07^{eB}	68.05^{dB}	67.92^{eC}	67.51^{dD}
a	Control	0.32^{eC}	0.37^{dB}	0.38^{eAB}	0.39^{eA}	0.40^{dA}
	T1	0.48^{dC}	0.49^{dC}	0.52^{dB}	0.59^{dA}	0.60^{cA}
	T2	0.75^{cE}	0.78^{cD}	0.87^{cC}	1.03^{cB}	1.14^{bA}
	T3	1.04^{bD}	1.06^{bD}	1.10^{bC}	1.91^{bB}	2.61^{aA}
	T4	1.66^{aE}	1.74^{aD}	1.79^{aC}	2.05^{aB}	2.82^{aA}
b	Control	15.66^{aA}	15.62^{aB}	15.52^{aA}	15.34^{aA}	15.06^{aB}
	T1	15.48^{bB}	15.42^{bB}	15.30^{bA}	15.24^{bB}	14.83^{bB}
	T2	15.68^{aAB}	15.66^{aAB}	15.58^{aB}	15.53^{aA}	15.12^{aC}
	T3	15.48^{bA}	15.41^{bA}	15.32^{bA}	14.38^{cB}	14.06^{cB}
	T4	15.40^{cA}	15.38^{cB}	15.17^{cB}	14.20^{cC}	14.01^{cD}

All values are mean ± SD of the three replicates.

$^{a-e}$ Means sharing different letters in the same column are significantly different (p<0.05).

$^{A-D}$ Means sharing different letters in the same row are significantly different (p<0.05).

Control: sausage with 1.5% NaCl, T1: sausage with 1.0% NaCl + 0.05% ascorbic acid, T2: sausage with 1.0% NaCl + 1.0% fermented red beet, T3: sausage with 1.0% NaCl + 3.0% fermented red beet, T4: sausage with 1.0% NaCl + 5.0% fermented red beet.

These low-salt sausages with fermented red beet added were significantly different in textural attributes when different amounts of fermented red beet were added. These low-salt sausages with fermented red beet added had lower values in hardness, gumminess, and chewiness than the control during refrigerated storage. Increasing the level of fermented red beet from 1.0% to 5.0% decreased the values in hardness, gumminess, and chewiness during refrigerated storage. The springiness of sausage samples was not significantly (p>0.05) different among treatments or storage periods.

Table 3 Changes in TPA of sausages formulations with fermented red beet during refrigerated storage

Parameters		Storage period (week)				
		0	1	2	3	4
Hardness (g)	Control	856.26^{aA}	824.81^{aA}	853.46^{aA}	863.71^{aA}	657.18^{aB}
	T1	848.07^{aA}	831.91^{aA}	822.20^{aA}	884.15^{aA}	696.94^{aB}
	T2	749.14^{bA}	638.99^{bB}	638.99^{bAB}	711.67^{cAB}	560.79^{bC}
	T3	700.85^{bB}	667.28^{bB}	667.28^{bB}	774.31^{bA}	671.86^{aB}
	T4	570.21^{cA}	477.79^{cB}	477.79^{cB}	550.79^{dA}	407.40^{cC}
Springiness (cm)	Control	0.96	0.94	0.93	0.92	0.91
	T1	0.95	0.94	0.91	0.91	0.90
	T2	0.94	0.93	0.92	0.90	0.90
	T3	0.92	0.92	0.92	0.91	0.91
	T4	0.92	0.92	0.90	0.92	0.91
Cohesiveness	Control	0.84^{aA}	0.82^{B}	0.82^{aB}	0.82^{abB}	0.82^{abB}
	T1	0.81^{ab}	0.81	0.79^{b}	0.81^{b}	0.79^{bAB}
	T2	0.79^{bB}	0.81^{AB}	0.81^{aAB}	0.82^{abA}	0.81^{ab}
	T3	0.80^{b}	0.82	0.82^{a}	0.82^{a}	0.83^{a}
	T4	0.84^{a}	0.81	0.81^{ab}	0.81^{ab}	0.81^{ab}
Gumminess	Control	705.99^{aA}	708.54^{aA}	698.36^{aA}	604.58^{aA}	537.92^{aB}
	T1	681.98^{aA}	661.50^{aA}	653.47^{aA}	612.77^{aA}	551.05^{aB}
	T2	591.90^{bA}	585.06^{bA}	585.06^{bA}	541.96^{bA}	555.30^{aB}
	T3	558.46^{bB}	573.61^{bB}	573.61^{bB}	489.41^{cA}	455.88^{bB}
	T4	464.17^{cA}	461.06^{cA}	461.06^{cB}	347.33^{dA}	331.85^{cC}
Chewiness	Control	719.65^{aA}	888.77^{aA}	669.54^{aA}	692.13^{aA}	515.73^{abB}
	T1	710.95^{aA}	635.55^{aAB}	628.00^{aB}	696.31^{aAB}	531.12^{abC}
	T2	544.89^{bA}	545.18^{bA}	538.18^{bB}	622.61^{bA}	537.04^{aB}
	T3	515.39^{bA}	536.73^{bA}	527.67^{bA}	563.15^{cA}	419.70^{abB}
	T4	477.21^{bA}	448.60^{cA}	448.60^{cA}	421.10^{dA}	389.49^{bB}

All values are mean ± SD of the three replicates.

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$^{A-D}$ Means sharing different letters in the same row are significantly different (p<0.05).

Control: sausage with 1.5% NaCl, T1: sausage with 1.0% NaCl + 0.05% ascorbic acid, T2: sausage with 1.0% NaCl + 1.0% fermented red beet, T3: sausage with 1.0% NaCl + 3.0% fermented red beet, T4: sausage with 1.0% NaCl + 5.0% fermented red beet.

The appearance, color, and juiciness scores of low-salt sausage samples with fermented red beet added were slightly lower than those of the control. However, the appearance, color, and juiciness of low-salt sausage samples were not significantly (p>0.05) different among all treatments. The appearance, color, and juiciness scores of the control and all treatments were slightly decreased with increasing storage period. The overall acceptability scores were decreased with increasing fermented red beet levels. The overall acceptability scores of all treatments were also decreased with increasing storage period.

Table 4 Changes in sensory characteristics of sausages formulations with fermented red beet during refrigerated storage

Parameters		Storage period (week)				
		0	1	2	3	4
Color	Control	7.23	7.16	6.83	6.67	6.17
	T1	7.08	7.13	7.08	6.65	6.18
	T2	7.32	7.17	7.13	6.83	6.21
	T3	7.42^{A}	7.08^{AB}	7.02^{AB}	6.92^{B}	5.63^{C}
	T4	6.84	7.01	6.80	6.64	6.25
Flavor	Control	7.22^{A}	7.21^{A}	6.63^{A}	6.58^{aA}	5.23^{abB}
	T1	6.84^{A}	6.62^{A}	6.82^{A}	4.89^{bB}	4.08^{bB}
	T2	7.28^{A}	7.07^{AB}	6.92^{AB}	5.63^{abB}	5.03^{aB}
	T3	7.42^{A}	7.23^{A}	6.87^{AB}	5.82^{abBC}	5.02^{abC}
	T4	7.22^{A}	6.82^{AB}	6.42^{ABC}	5.43^{abBC}	5.01^{abC}
Tenderness	Control	7.68^{A}	7.23	6.89	6.82	6.67_{a}
	T1	7.23^{A}	7.03^{A}	6.85^{AB}	5.84^{BC}	4.83^{cC}
	T2	7.45^{A}	7.21^{A}	7.08^{A}	5.87^{B}	6.02^{aB}
	T3	7.06^{AB}	7.22^{A}	7.05^{AB}	6.23^{BC}	5.63^{abC}
	T4	6.82^{A}	7.09^{A}	6.63^{A}	5.87^{B}	5.03^{bB}
Overall acceptability	Control	7.66^{A}	7.23^{A}	6.64^{AB}	5.83^{B}	5.81^{aB}
	T1	7.08^{A}	6.85^{A}	6.62^{A}	4.61^{B}	4.43^{B}
	T2	7.21^{A}	6.98^{A}	6.67^{AB}	5.89^{B}	6.02^{aAB}
	T3	7.09^{A}	6.88^{A}	6.65^{A}	5.47^{AB}	5.24^{abB}
	T4	6.65^{A}	6.81^{A}	6.28^{A}	5.08^{B}	4.22^{B}

All values are mean ± SD of the three replicates.

[a-e] Means sharing different letters in the same column are significantly different (p<0.05).

[A-D] Means sharing different letters in the same row are significantly different (p<0.05).

Control: sausage with 1.5% NaCl, T1: sausage with 1.0% NaCl + 0.05% ascorbic acid, T2: sausage with 1.0% NaCl + 1.0% fermented red beet, T3: sausage with 1.0% NaCl + 3.0% fermented red beet, T4: sausage with 1.0% NaCl + 5.0% fermented red beet.

IV. CONCLUSION

In this experiment we showed that reducing salt levels from 1.5% to 1.0% with the addition of fermented red beet can maintained the quality characteristics of reduced-salt sausages. These results demonstrated that fermented red beet could be added to low-salt sausages to maintain their qualities of refrigerated storage.

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