SODIUM REDUCTION IN BEEF PATTIES – HOW TO OVERCOME THE EFFECTS ON SHELF LIFE, TASTE AND COLOR

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Abstract – The aim of this study was to investigate the effects of sodium reduction on the shelf life, taste and color of beef patties. A second step was to investigate how to prevent that these effects from occurring. The sodium level of the control patties were taken from the 2012 FSA targets. In this study we found that due to the reduction of the sodium levels the water activity of the patties increased and hence the shelf life decreased. Also the color stability reduced. Finally there was a significant effect (p<0.05) on the salt perception. These negative effects of the reduction of the sodium level in the beef patties could be restored using various (combinations of) organic acids or ferments.

Key Words – fresh meat, salt reduction

I. INTRODUCTION

The current overconsumption of sodium is considered a human health threat as it is linked to hypertension and consequently to stroke and cardiovascular diseases. Therefore the WHO recommends a daily consumption of 5g sodium chloride (salt) a day. The FSA (Food Standards Agency) and NSRI (National Salt Reduction Initiative) defined sodium reduction targets for specific meat categories and other organizations are likely to follow.

This study focuses on the effects of sodium reduction in fresh meet, e.g. beef patties. The 2012 FSA targets in this type of application are 0.75 % salt or 0.3 % sodium [1]. Complying with these targets leads to challenges in bacterial growth, taste and color stability. These challenges affect shelf-life, food safety, technical performance and consumer preference.

Often, solutions are offered for only one of these problems. However, none of these factors can be compromised to deliver an acceptable product. Therefore in this study is also tried to find a solution to all of these problems. This is done by using the potassium salts of organic acids as well as fermented sugar with and without vinegar.

II. MATERIALS AND METHODS

The beef patties were made according to a general formulation (see Table 1).

Table 1 Beef patty formulations

	Contr. 1.4 % salt	Contr. 0.75% salt	FS	FSV	PL	PLPA
beef trims	92.6	93.25	90.92	90.30	91.43	91.55
water	5.0	5.0	5.0	5.0	5.0	5.0
salt	1.4	0.75	0.75	0.75	0.75	0.75
dextrose	0.6	0.6	0.6	0.60	0.60	0.60
pepper	0.15	0.15	0.15	0.15	0.15	0.15
nutmeg	0.10	0.10	0.10	0.10	0.10	0.10
mace	0.05	0.05	0.05	0.05	0.05	0.05
sodium-glutamate	0.05	0.05	0.05	0.05	0.05	0.05
sodium-ascorbate	0.05	0.05	0.05	0.05	0.05	0.05
fermented sugar (FS)			2.33			
fermented sugar + vinegar (FSV)				2.98		
potassium -lactate (PL)					1.73	
potassium -lactate + potassium -acetate (PLPA)						1.88

Each batch of treatment was prepared in duplicate, individually packed and incubated at 4°C. Duplicate samples for each treatment were independently analyzed at defined intervals in duplicate plates for microbiological counts on TSA and MRS counts.

The patties were also analyzed on pH and water activity. The color of the samples is evaluated every day visually. This evaluation consisted of color description with words.

Two descriptive taste tests were done with 8 trained persons. The patties were given cooked and stored warm in aluminum foil until the taste session started. The patties were scored on the attributes salt and bitter. The patties were scored on a 6 point scale: 0 means not detected; 5 means strong. The samples were presented in a randomized order. Each panelist tasted each sample once. The results of these tests were analyzed with use of Compusense 5.0 software, using a Tukey HSD-test with α=5%.

III. RESULTS AND DISCUSSION

Microbiological stability

Table 2 shows the results of the water activity and pH measurements. There is a difference in water activity between the control sample containing 0.75% salt and the other samples. With the use of either the fermented sugar (+/- vinegar) or the salts of organic acids, the water activity can be restored to the level of the control with1.4% salt. There are also differences observed in the pH of the samples. The pH of both the 1.4% and the 0.75% salt control samples are lower compared to the samples with the organic acid-salts or fermented sugar.

Table 2 a_w and pH values

	Water activity	pH
Control 1.4% salt	0.973	5.96
Control 0.75% salt	0.979	5.97
FS	0.974	6.08
FSV	0.973	6.10
PL	0.973	6.08
PLPA	0.974	6.08

In Figure 1, the microbiological results are shown. The results show that a decreased salt level has a negative effect on the shelf life of the product. The addition of the organic acids or fermented sugar in the reduced salt samples helps to achieve the same shelf life as the control sample with 1.4% salt. The results from Figure 1 indicate significant difference ($p<0.01$) between the low salt control and the treatments containing antimicrobial interventions.

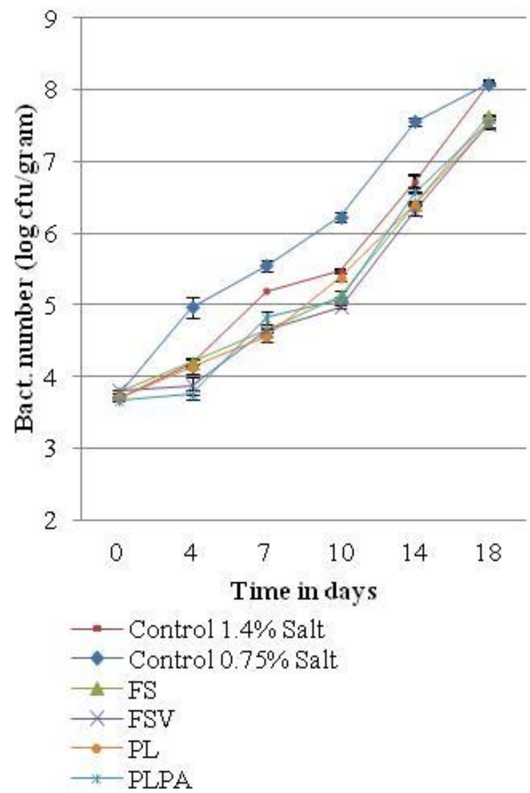

Figure 1. Microbiological results: Total plate count on TSA. Data points are average values of duplicates.

Color stability

The overall ranking of the samples packed under modified atmosphere are from best to worst:

PLPA > PL > FSV > FS > Control 1.4% Salt > Control 0.75% Salt.

The visual observations show that the low salt control already discolored from bright red to dark red after 4 days, whereas for the other samples this was seen at day 7. The low salt control was grey after 10 days, whereas the 1.4% salt control was grey-red at day 10. The treated samples were all still red at day 10. The red color varied from dark red for the samples with the fermented sugar to pale red for the samples with lactate. At day 15 all samples were grey.

It is known that lactate can help to enhance color stability. It has been reported that the addition of lactate improves color stability by lactate-mediated enzymatic reduction of metmyoglobin [2]. Figure 2 shows the mechanism of lactate enhanced improved color stability of bovine muscles by increasing the reducing activity through increased NADH via elevated LDH-B flux (catalyzing toward NADH generation). Also a higher pH will help in color stability. All the samples which contain an extra ingredient did have a higher pH. A higher pH can give a higher metmyoglobine reductase activity to deoxymyoglobine [3]. A lower pH can give more auto-oxidation to metmyoglobine [4].

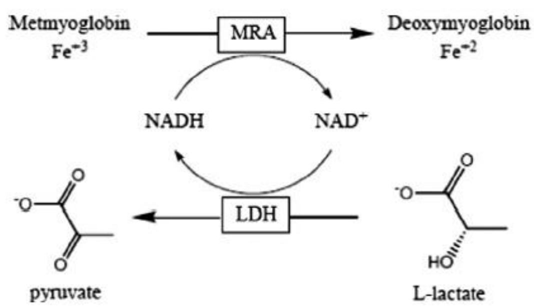

Figure 2. Mechanism of the lactate–lactate dehydrogenase (LDH) system for generating NADH for metmyoglobin-reducing activity (MRA)

Taste

The taste was evaluated in two series. The first series contained the samples with the fermented sugar (FS and FSV) and the second series contained the samples with lactate (PL and PLPA).

In Figure 3 the results of the first taste session are shown. In this first session the effect of the fermented sugar and the combination fermented sugar with vinegar on taste in low sodium patties was tested. Only for the attribute salt a significant difference ($p<0.05$) is observed. The 1.4% salt control and the FSV sample are significant higher in salt perception compared to the 0.75% salt control and the FS sample.

Although the FS sample scored lower on saltiness than the control with 1.4% salt, the saltiness was increased compared to the control with 0.75% Salt. However, this enhanced saltiness appears not to be significant ($\alpha=5\%$).

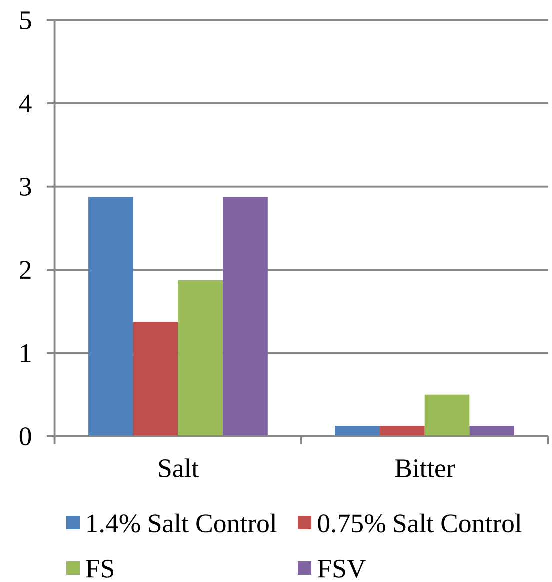

Figure 3. Average score of the taste test with the FS and FSV samples

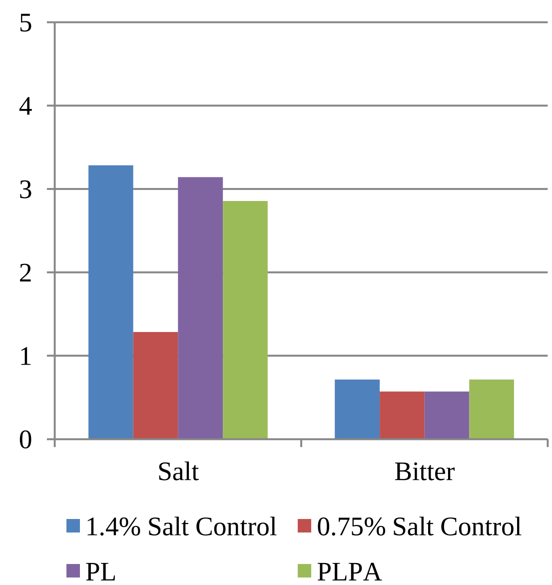

Figure 4. Average score of the taste test with the PL and PLPA samples

In Figure 4 the results of the second taste session are shown. In this second session the effect of potassium-lactate and a combination of potassium lactate + potassium-acetate on taste in low sodium patties was tested. Only for the attribute salt, a significant difference ($p<0.05$) is observed. The use of the potassium-salts of lactate and acetate restored the salty taste completely.

IV. CONCLUSION

Lowering the salt level towards the FSA target of 2012 will negatively affect fresh meat products. The products are less stable in color, the microbiological growth is faster and the taste is less salty.

The reduction in the quality of all these factors can be compensated for with use of either organic acids or fermented sugar.

DISCLAIMER

Noting contained herein shall be taken as an inducement or recommendation to manufacture or use any of the described materials or processes in violation of existing or future patents of PURAC or any other party.

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