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# TEXTURE AND PLASTICITY OF CHOPPED CANNED MEAT PRODUCTS AS AFFECTED BY VARIOUS VOLUMES OF WATER ADDED TO THE BATTER

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## ABSTRACT

This work was aimed to investigations of the effect of different volumes of water added to the batter on texture parameters of model canned meat product. The INSTRON 1140 was used for determinations of texture parameters: the TPA test , cutting test with single Warner-Bratzler knife and single compression test till 80% of the sample height. The variance analysis and regression analysis were applied for the data evaluation. The results indicate that the volume of water added to the batter affects the parameters of texture of model canned meat product. Most of texture features analyzed were decreasing as the amount of water increased. The relations between most texture parameters were of the linear regression type. Also, for the cohesion and elasticity, non-linear relationships were found.

**Key words:** meat, chopped meat, water, texture

## INTRODUCTION

Water added to meat during the chopping becomes major technological additive and plays important role in formation of batter structure. This is due to the hydration and dissolving of proteins released from meat fibers. Added water with low molecular weight components dissolved in, forms the dispersive phase. This facilitates thermal hydrolysis of scleroproteins, improves juiciness and sensory palatability. Water affects also the production yield [1, 5, 6, 7, 9, 12]. The amount of water added determines the protein to water ratio. The batter with insufficient water content appears to be "under - chopped" and the product is of low juiciness. The excess of water added during the chopping causes the decrease of cohesion, i.e. the binding between protein micelles weakens.

According to Gorbatow et all [4], for each type of batter there is the optimal volume of water to be added to and such volume determines technologically most advantageous shortest chopping time. Poulanne and Russunen [10] maintain, that water binding capacity increases until certain volume of water added and then decreases. Ławrowa [9] observed the improvement of sausage quality for 30% - 35% of water added, for higher volumes the quality features worsened, particularly the consistence. Research of Dolata [3] proved, that the hardness of sausages was decreasing as the amount of water added to the batter increased.

This work was aimed to determination of the effect of different volumes of water added to the batter on the texture and flow limits of model canned meat product.

## MATERIALS AND METHODS

The experiments were conducted under semi-technical conditions. The chopper of 10 $dm^3$ bowl capacity was used. Three logarithmic knives of slip coefficient $\lambda = 1.5$ were mounted on the shaft. Rotational speed of the shaft was 50 rps and that of the bowl - 0.3 rps.

For the processing of model canned product the pork shank (the hock) meat and trimmed ham fat were used. Carcasses were chilled after the slaughter for 24 hrs, then the shank was debonned. Meat of III-rd grade and fat were grinded through 3 mm plate, salt and curring mixture were added to. Temperature of 4° - 6°C was maintained during 24 hrs of curring.

During chopping of meat and fat different volumes of iced water were added: from 10% to 50% of the stuffing weight, with 10% intervals. After the chopping, round shaped tin cans of 300 g capacity were filled with the batter and the cans were pasteurized in water of 75°C, until the temperature of 72°C was reached in the middle of cans. Following the cooling with cold water, the cans were stored for 24 hrs in 4° - 6°C.

Texture of the stuffing was measured using the INSTRON 1140 model. For the TPA test the samples were compressed twice to 50% of theirs initial height and the head speed applied was $8 \times 10^{-4}$ m/s. The Warner-Bratzler knife with speed of $8 \times 10^{-3}$ m/s was used for cutting test [11]. Single compression of the samples to 80% of initial height at the head speed of $1.67 \times 10^{-3}$ m/s was also measured. For the compression tests, the samples of $\varphi = 2.5 \times 10^{-2}$ m and of $2 \times 10^{-2}$ m in height were used.

Texture parameters were evaluated from the texture profile chart, as it was described by Bourne [2], and these were: the highest compression force of first head run (hardness 1), the highest compression force of second head run (hardness 2), the cohesion and the elasticity.

The highest cutting force ($F_{max}$) and the cutting work ($A_c$) were evaluated from the cutting test. From single compression test data regarding the yield point, an end compressive stress, the deformation limit with it's strain force and deformation coefficients $\alpha_1$, $\alpha_2$ were obtained [8].

The INSTRON 1140 was interfaced with IBM PC. The measurements were controlled by installed software. Data were saved in HD for further statistical analysis.

## RESULTS AND DISCUSSION

Data regarding the texture properties of model canned meat product as affected by the amount of water added to the batter are presented in Table 1. The results of variance analysis proved statistically significant influence on the texture parameters measured.

**Table 1. Texture parameters of model canned meat product as affected by the amount of water added to the batter [mean values]**

| Parameter | Percentage of water added | | | | | Least significant difference | |
|---|---|---|---|---|---|---|---|
| | 10 | 20 | 30 | 40 | 50 | $\alpha$ =0.05 | $\alpha$ =0.01 |
| Hardness 1 [N] | 48.32 | 34.19 | 30.33 | 29.59 | 18.24 | 2.04 | 2.72 |
| Hardness 2 [N] | 44.35 | 29.84 | 26.34 | 26.09 | 16.42 | 2.10 | 2.80 |
| Highest cutting force [N] | 7.11 | 7.44 | 5.91 | 4.93 | 4.61 | 0.90 | 1.20 |
| Cutting work [J] | 0.161 | 0.162 | 0.129 | 0.107 | 0.098 | 0.019 | 0.026 |
| Cohesion | 0.677 | 0.644 | 0.648 | 0.646 | 0.712 | 0.042 | 0.056 |
| Elasticity [mm] | 7.12 | 7.32 | 7.47 | 7.31 | 6.90 | 0.29 | 0.38 |
| Deformation coef. $\alpha_1$ [N/m$^2$] x10$^4$ | 12.98 | 10.65 | 6.96 | 5.03 | 2.83 | 1.19 | 1.59 |
| Deformation coef. $\alpha_2$ [N/m$^2$] x10$^4$ | 20.24 | 15.94 | 12.57 | 9.08 | 6.62 | 1.32 | 1.76 |
| Deformation limit [%] | 53.30 | 55.85 | 53.65 | 54.00 | 56.75 | 3.47 | 4.63 |
| Strain force [N] | 70.80 | 57.03 | 47.59 | 37.45 | 30.00 | 6.46 | 8.62 |
| Yield point [N/m$^2$] x10$^4$ | 14.42 | 11.62 | 9.70 | 7.63 | 6.11 | 1.32 | 1.76 |
| Compression stress [N/m$^2$] x10$^4$ | 18.82 | 16.46 | 13.01 | 10.35 | 8.10 | 1.26 | 1.68 |

Hardness 1 and 2 were decreasing as the amount of water increased and water- effect relation was of the linear regression type, as in Fig 1. Similar relationship can be calculated for cutting work and cutting force – Fig 2.

**Fig 1. Effect of water volume added on hardness 1 and 2**

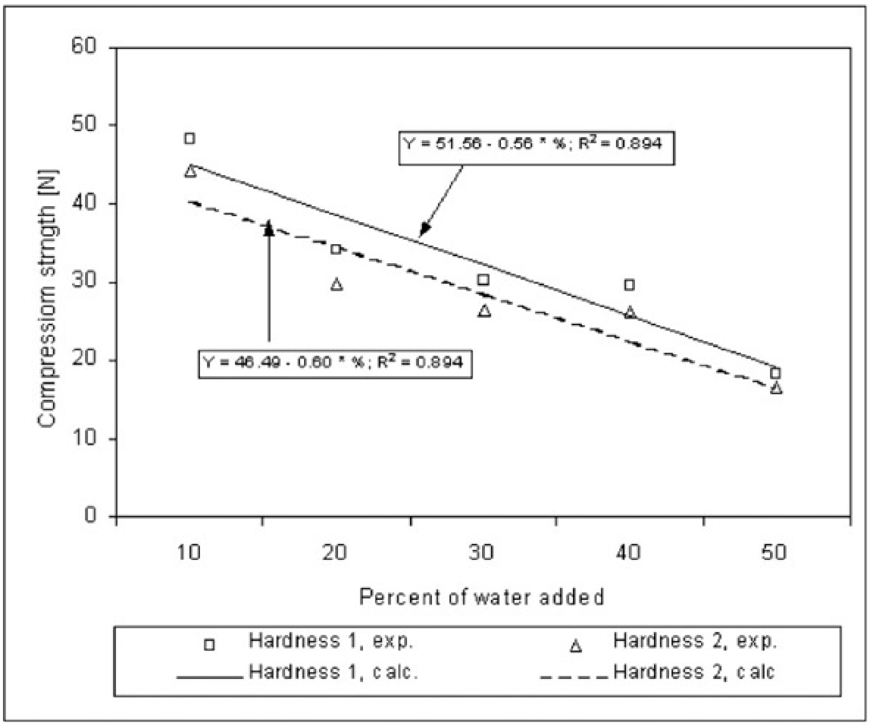
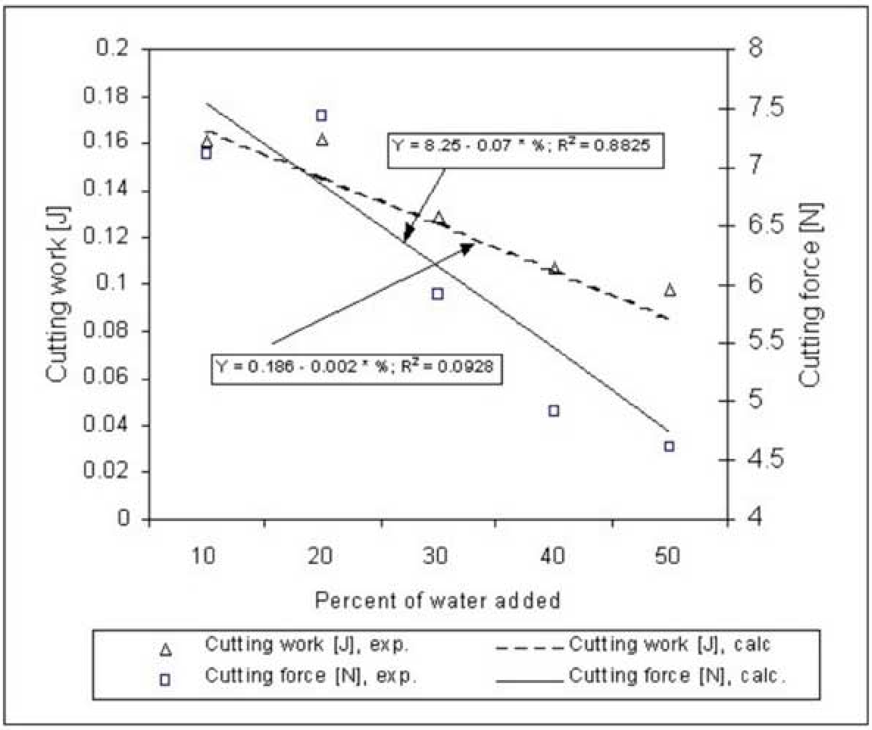



**Fig 2. Effect of water volume added on highest cutting force and cutting work**




For elasticity and cohesion the water-effect relationships were of non-linear type (Fig.3). The changes of cohesion can be described by rational function, with the inflection point around 30%. For this range the lowest values of cohesion has been found. This is interesting, that for the same volume of water added, the highest elasticity values were observed. The function describing water-elasticity relation is of the Gauss type.

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The deformation coefficients $\alpha_1$ and $\alpha_2$, the compression stress and yield point decreased linearly as the volume of added water increased. This refers also to changes of strain force, but changes of deformation limit seemed not to be of regular character. For this parameter, general increasing trend can be observed, however the regression equation does not fit the data with satisfactory accuracy. Changes of these parameters are presented in Figs. 4, 5 and 6.

**Fig 3. Effect of water volume added on cohesion and elasticity**

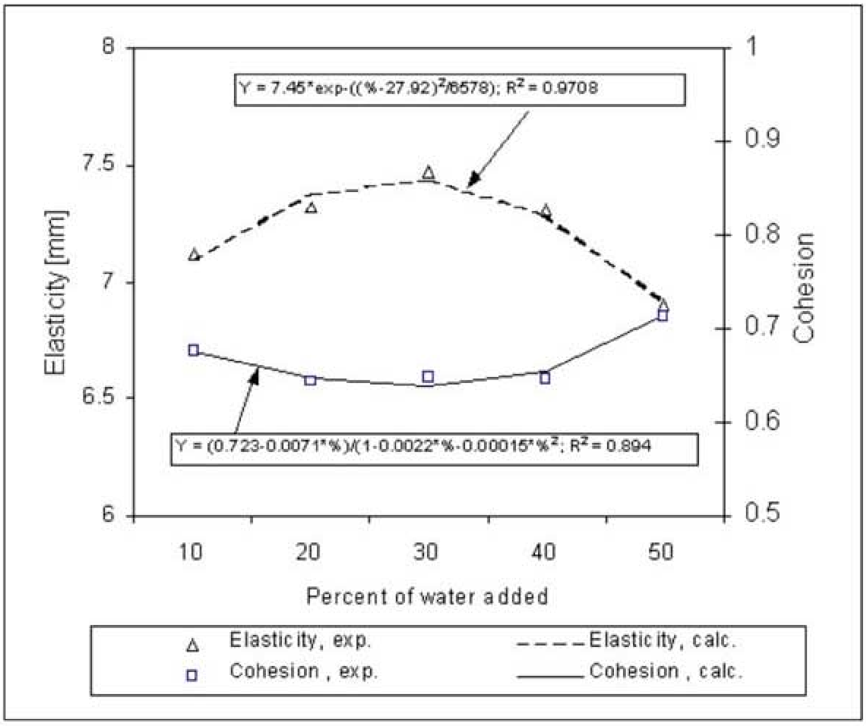


**Fig 4. Effect of water volume added on alfa-1 and alfa-2 deformation coefficients**

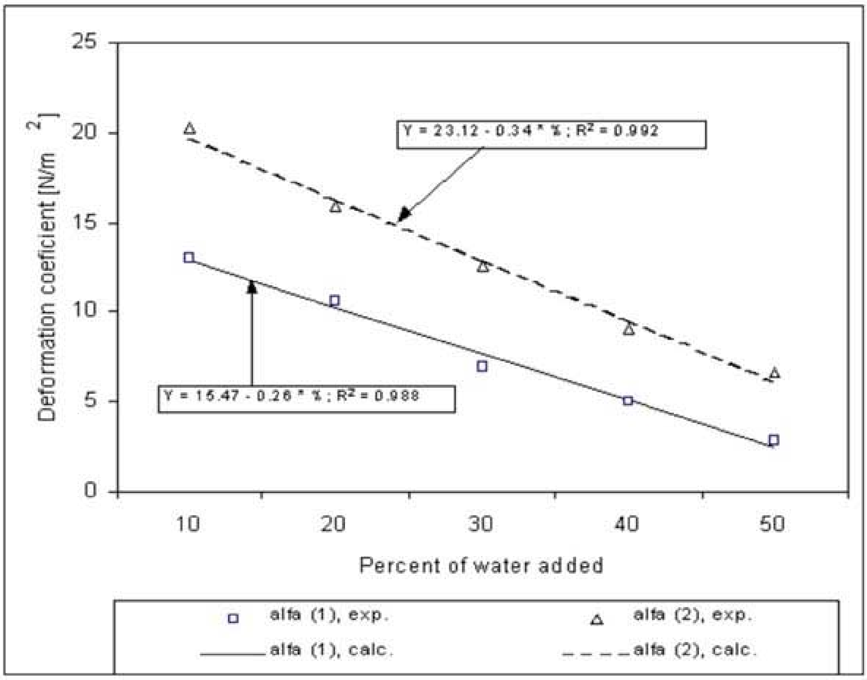


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**Fig 5. Effect of water volume added on compression stress and yield point**

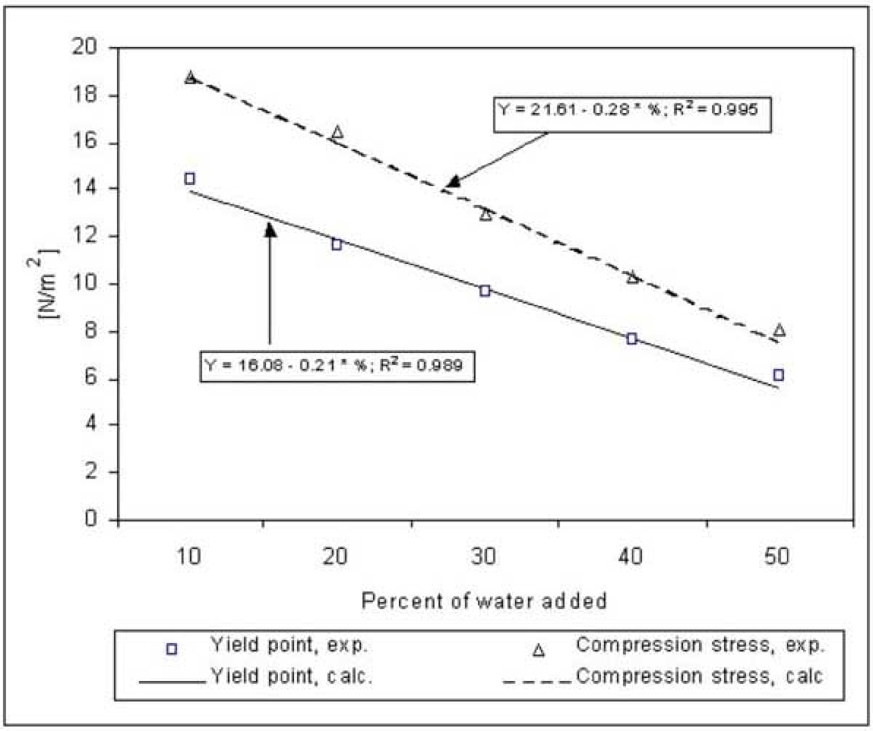
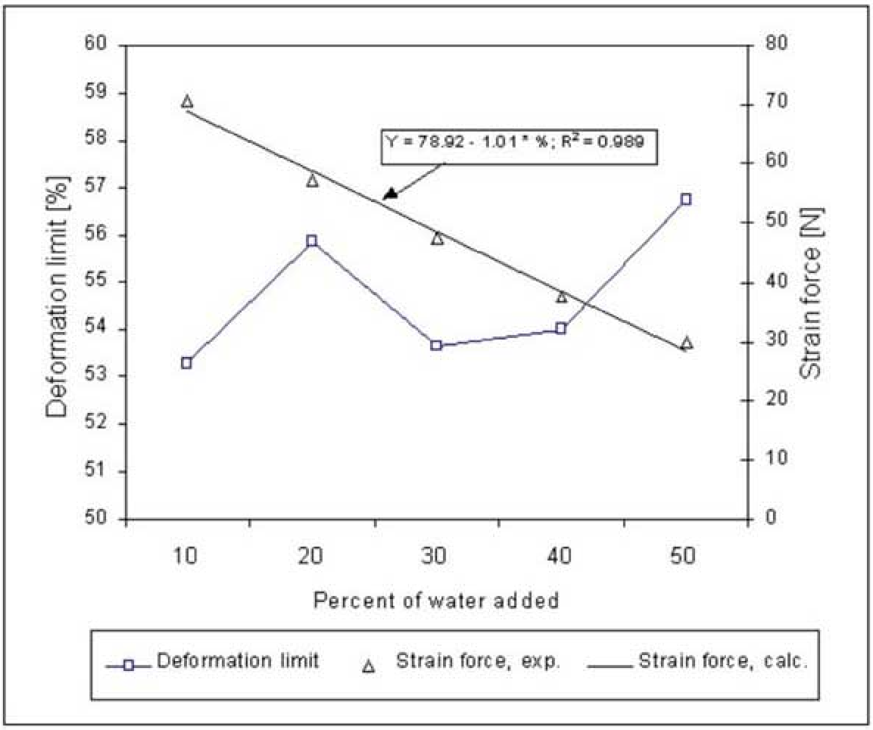



**Fig 6. Effect of water volume added on deformation limit and strain force**




Generally, most of investigated texture parameters showed the tendency for decreasing, as the amount of water added increased. This was probably due to change of the ratio of water: protein and dilution of proteins, which are major binding component. Highest elasticity found at 30% of the water added indicates, that this is an optimal volume and also confirms the findings of Ławrowa [9].

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The relationships between texture parameters and the amount of water added were in most cases of the linear type. Therefore this seemed reasonable to compute the correlation coefficients between texture features. The results of calculations are summarized in Table 2.

**Table 2. Statistically significant correlation coefficients between texture parameters measured in model canned meat product**

| Parameter | Hardness 1 [N] | Hardness 2 [N] | Highest cutting force [N] | Strain force [N] | Yield point $[N/m^2] \times 10^4$ | Compression stress $[N/m^2] \times 10^4$ | Deformation coefficient $\alpha_1$ $[N/m^2] \times 10^4$ |
|---|---|---|---|---|---|---|---|
| Hardness 2 [N] | 0.987 | | | | | | |
| Cutting work [J] | | | 0.884 | | | | |
| Strain force [N] | 0.846 | 0.832 | | | | | |
| Yield point $[N/m^2] \times 10^4$ | 0.847 | 0.831 | | 0.972 | | | |
| Compression stress $[N/m^2] \times 10^4$ | 0.849 | 0.829 | | 0.863 | 0.879 | | |
| Deformation coef. $\alpha_1$ $[N/m^2] \times 10^4$ | 0.845 | 0.841 | | 0.851 | 0.865 | 0.914 | |
| Deformation coef. $\alpha_2$ $[N/m^2] \times 10^4$ | 0.896 | 0.883 | | 0.942 | 0.945 | 0.910 | 0.944 |

Highest values of correlation coefficients are for hardness 1 and hardness 2 ($r = 0.987$). Also high values of r were found for strain force and the yield point ($r = 0.972$), for the yield point and $\alpha_2$ deformation coefficient ($r = 0.945$). The r values between $\alpha_1$ and $\alpha_2$ deformation coefficients were also high ($r = 0.944$). For the strain force and $\alpha_2$ $r = 0.942$, for compression stress and $\alpha_1$ & $\alpha_2$ ($r = 0.914$ and 0.910, respectively). Hardness 1 was correlated with $\alpha_2$ and r was 0.896.

Although the relationships between texture parameters and the amount of water added to the batter, as presented in the form of simple linear regressions, these might became a tool for he prediction of technological effects of addition of water. Also these can be used for purposes of optimization of the batter composition and control of product quality.

## CONCLUSIONS

1. The amount of water added to the batter affects the texture parameters of model canned meat product. Most of the parameters investigated decreased linearly as the amount of water increased, except the yield point. For the cohesion and elasticity non-linear relationships were found.

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2. Under experimental conditions the amount of 30% of water added was found to be optimal.
3. The relationships between the amount of water added to the batter and texture parameters might be applied for optimization purposes and for prediction of product quality.
4. Statistically significant correlations between texture parameters of model canned meat were also found.

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