## Estimation of water activity based on water content and dry matter-to-fat ratio in salami

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**Objectives** Our research aimed to determine whether reaching the **34% moisture limit\*** in paprika salami also indicates that water activity is below the required 0.95\*. We analyzed moisture, fat content, and water activity, exploring whether the latter can be estimated based on the product's composition before filling and its current water content during ripening. (\*Hungarian Food Code)

Materials and Methods Samples of SPAR pepper salami filled on 06. 02. 2025., were taken on days 0/4/7/11/13/15/18. Three parallel measurements were made from each: fat, moisture, protein and water content, as well as cross-sectional and surface water activity. The chemical properties of the paste (see Figure 1) and the water activity (see Figure 2) were determined. Knowing the measurement data, the fat-free equivalent water content can be calculated, based on which the water activity can be determined by regression. (see Figure 3)

## **Results** It can be seen that:

equivalent fat-free water content can be determined by the eq.: c = a\*cw/(a-1+cw),
equivalent fat-free water ratio can be determined by the eq.: x = a\*cw/(a-1+cw-a\*cw),
a: dry matter/fat ratio, which is 1.594 (sd = 0.022). Results are illustrated in Figures 4 and 5.





components of salami during ripening





saturation

• AICc

Figure 3. The process of developing the water activity estimation models ffwc: fat free water content, ffwr: fat free water ratio, a: dry material / fat ratio, c, : water content

For fat-free equivalent water content, a linear regression  $(a_w \sim A_1 + B_1^*(c_{eq} - C_1))$ , with  $A_1, B_1, C_1$  parameters), and for fat-free equivalent water ratio two nonlinear functions were fitted:

• an inverse  $(a_w \sim A_i + B_i/(x_{eq} - C_i))$ , where  $A_i, B_i, C_i$  are parameters) • and a saturation  $(a_w \sim 1 - e^{-As * xeq - Bs})$ , where  $A_s, B_s$  are parameters)

See Table 1 for the fitted parameters and the regression quality characteristics.

Based on water content + dry matter/fat ratio  $\rightarrow$  water activity curves estimated are shown in Figures 6-8. It can be observed that although the shapes of the curves are different, the crossing point of the 0.95 water activity is determined similarly.

**Conclusions** The chemical characteristics showed fluctuations (sd = 0.022 for dry matter/ fat ratio), which **should be minimized** for accuracy of water activity estimation. It is important to mix the paste homogeneously and to avoid the separation and clumping of fat particles during filling. Modern, accurate production machines are the basic conditions for the applicability of data-based decision-making.

All the three regression models confirm that if the water content limit (34%) value is met, the water activity is also adequate (0.95). For products for which this relationship can BE PROVEN, WATER ACTIVITY CAN BE OMITTED FROM THE PARAMETERS INDICATING THEIR COMPLETION, THUS MAKING THE FORECAST SIMPLER AND MORE EFFICIENT. It is recommended to explore the relationship between water content  $\sim$  water activity for each product.





Figure 6. Estimating water activity by linear model and achieving the water activity of 0.95 at the confidence interval \* The requirements of the Hungarian Food Code

Figure 2. Evolution of surface and cross-sectional water activity during ripening \* The requirements of the Hungarian Food Code



Figure 4. Calculated fat-free equivalent water content\* given the dry matter/fat ratio with confidence interval \*  $c_{ac}$  = water mass / fat-free total mass



Figure 5. Calculated fat-free equivalent water ratio\* given the dry matter/fat ratio with confidence interval \*  $x_{m}$  = water mass / fat-free dry matterial mass

R2	0,735	0,855	0,818
AICc	32,13	33,33	25,88



Figure 7. Estimating water activity by inverse model and achieving the water activity of 0.95 at the confidence interval \* The requirements of the Hungarian Food Code



Figure 8. Estimating water activity by saturation model and achieving the water activity of 0.95 at the confidence interval \* The requirements of the Hungarian Food Code



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