AN ALTERNATIVE METHOD FOR MEAT SHEAR ENERGY ESTIMATION DURING AGEING

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AIM. Development and evaluation of an alternative device based on GIM for estimation of beef shear energy during ageing. To measure shear energy of aged steak samples by GIM and by TMS PRO equipment, based on WB method.

Keywords: Warner Bratzler share force test, gravitational impulse method, beef shear energy.

Abbreviation key: MLD – *Musculus longissimus dorsi*, WB – Warner Bratzler, GIM – gravitational impulse method.

MATERIALD AND METHODS. Experimental device using **GIM** for estimation of meat shear energy was developed in the Department of Food Science and Technology of Estonian University of Life Sciences. To carry out measurements, a meat sample is placed on the cutting table between the shear blade and force plate, where the sample is penetrated by the free fall of the blade. After shredding the sample, the blade falls onto the force plate and its transducer generates an impulse, which is recorded by a measurement controller. The weight of the blade is 1.10 kg and its initial height from the force plate is 460 mm (Fig. 1a).

Physics of the GIM device bases on energy balance. If the blade is lifted to a certain altitude (h) it holds the potential energy (E_P) (Fig. 1b). While dropping the blade, the potential energy (E_P) turns into kinetic energy (E_K), the end value of which corresponds to the size of the impulse (i) generated by the force plate transducer 1 (Fig. 2). This can be estimated by calculation of the surface area under the graph of force dynamics. The meat sample on cutting table will consume a part of that energy (shear energy E_L), and the force transducer will record a lower result.

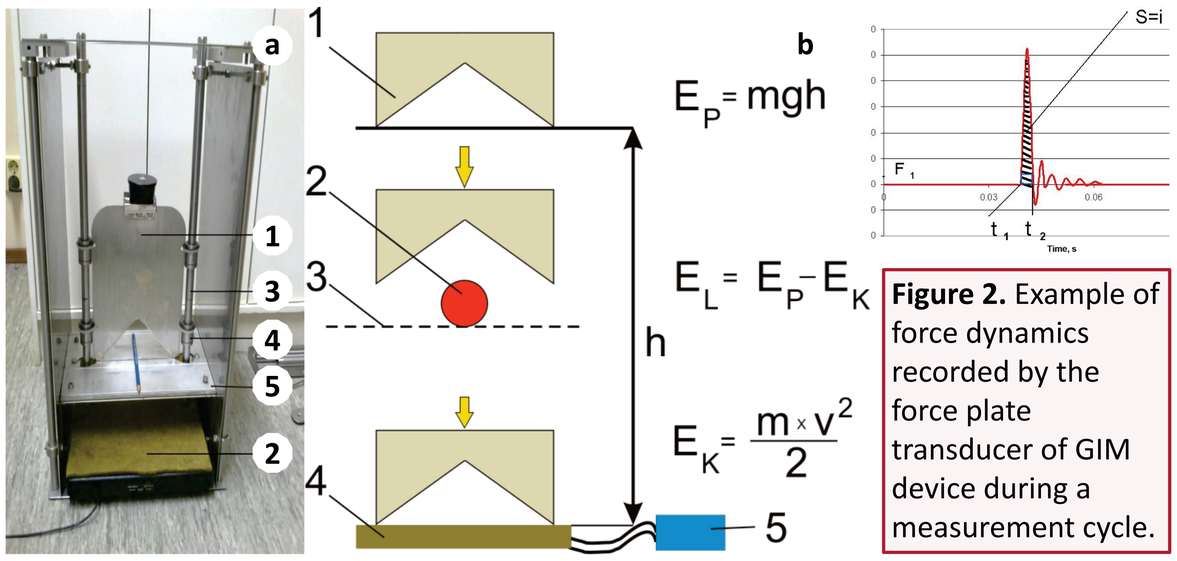

Figure 1.
a. The test device to determine the shear energy of meat by using gravitational impulse method (GIM) (1 – blade, 2 – force transducer, 3 – blade leading rods, 4 – slidebearing, 5 – cutting table)
b. GIM to determine the shear energy consumption of meat samples (1 – blade, 2 – probe, 3 – cutting table, 4 – force plate with transducer, 5 - measurement controller)

Figure 2. Example of force dynamics recorded by the force plate transducer of GIM device during a measurement cycle.

Texture analyzer TMS PRO with a 1000 N force transducer and blade movement speed of 500 mm min^{-1} was used for the WB method. Total shear energy consumption during cutting the probe was estimated by calculating the surface area under the force dynamic curve (Fig. 3). The blades in both (WB and GIM) devices had similar configurations with a 60° V-shaped incision and thickness of 1.016 mm).

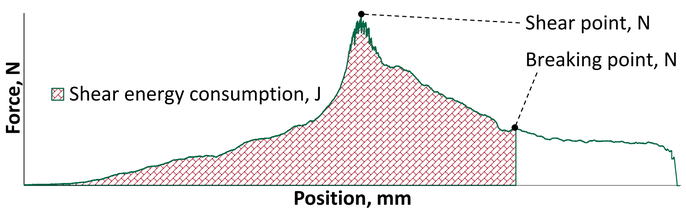

Figure 3. Force dynamics during Warner-Bratzleri test and its shear energy determination by calculating the surface area under the curve

Three deboned ***M. longissimus dorsi* muscles** (MLD) removed from the beef carcasses two days after the slaughtering. Each muscle was cut into six samples with the weight of about 300 g each and aged in vacuum packages at 0–2°C during 2, 7, 14, 21, 38 and 35 days. Probes were obtained from meat samples by using a hollow drill with inner diameter of 20 mm. Shear force dynamics of both, raw and thermally treated samples of aged beef was registered by WB and GIM methods. From force dynamics total shear energy was calculated later on. Probes were sheared from the middle perpendicularly to the muscle fibres in six separate trials. For thermal treatment, meat samples were heated in a water bath until the inner temperature reached 72–76˚C.

RESULTS. Raw meat. Ageing had statistical significance effect concerning WB method ($p < 0.001$) and GIM method ($p = 0.02$). Shear energy values obtained by GIM were bigger compared to the WB method (Fig. 4). Shearing energy decreased noticeably faster at the beginning of ageing period in comparison with the end of it. On the second day of ageing the shear energy consumption by GIM was 2.1 J (3.15–1.05 J) higher than that of WB. At the end of the ageing period (35 days) this difference decreased to 0.3 J. These data indicate the much greater sensitivity of GIM method at the first week of ageing, compared to the WB method.

Thermally treated and raw meat showed similar trends in changes of shear energy consumption for both (WB and GIS) methods (Fig. 5) with differences in statistical significance. Shearing of thermally treated meat with WB method showed decrease in shear energy consumption during ageing days significantly ($P < 0.001$), but GIM method did not show up significant difference ($P = 0.38$).
Therefore development of a new express device for evaluation the initial stage of meat ageing would be reasonable.

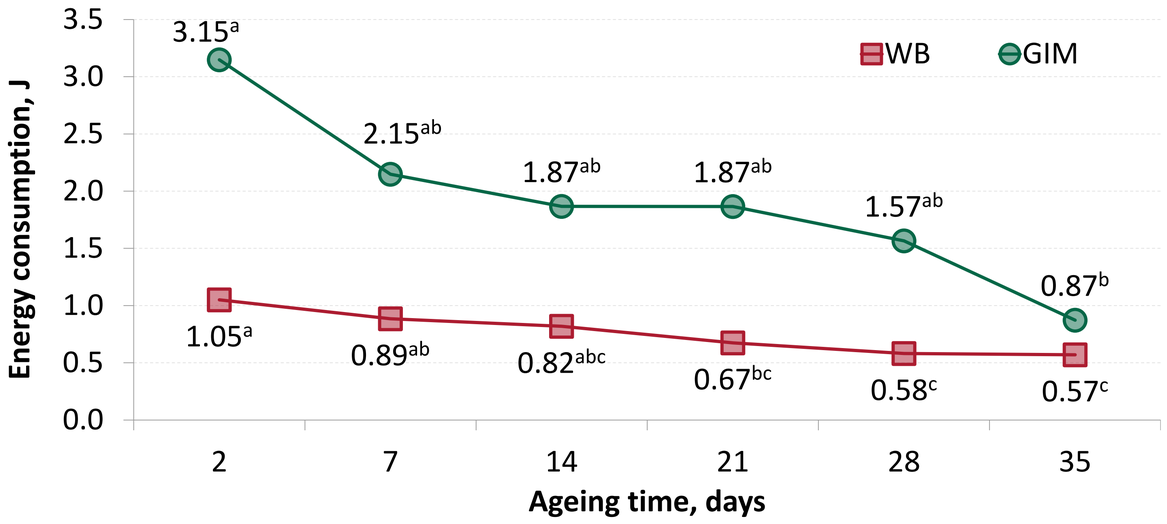

Figure 4. Effect of ageing to the raw meat shear energy consumption by using WB and GIM methods (means within each effect with one letter in common do not differ)

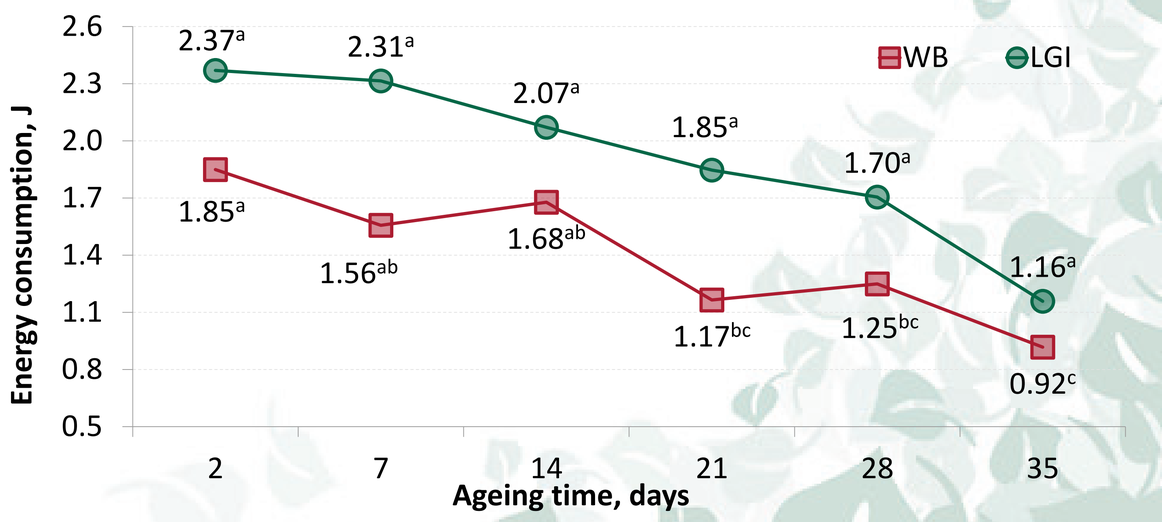

Figure 5. Effect of ageing on boiled meat shear energy consumption by using WB and GIM methods (means within each effect with one letter in common do not differ)

CONCLUSIONS. Effect of ageing on the structure of the meat can be determining both, by classical (WB) and by gravitational impulse method (GIM). GIM method is more sensitive for determination of aged raw meat tenderness compared to WB method. Advantage of gravitational method is its simplicity. On the base of GIM method, the development of a new texture analyzer for meat industry would be reasonable.