WATER ACTIVITY OF BELGIAN MEAT PRODUCTS : RELATIONSHIP WITH SOME PHYSICO-CHEMICAL OR MICROBIOLOGICAL PARAMETERS

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BACKGROUND

The conservability of food is highly influenced by the hurdle technology. Water activity (a_w) and pH are commonly reported as major factors of hurdle in meat products. These parameters can be measured by industry but are not available at a large scale in Belgium. Data from literature can not be applied to unknown products according to high variability of the manufacturing processes resulting from different degrees of drying, local habits, uses of specific ingredients or varying composition of the ingredients.

OBJECTIVES

The aim of the present experiment was to evaluate a_w and pH of different meat products manufactured in Belgium and to assess the contribution of NaCl as major a_w depressor.

MATERIAL AND METHODS

Material. The experimental material consisted of 79 meat products classified in cooked products, dry cured products and dry fermented products. The cooked products were separated in cooked ham, 'saucisson de jambon' (fine emulsion sausage in which cooked ham is partially used as protein, stuffed in plastic casing), 'pain de viande' (minced meat products), 'boudin' (blood sausage), 'pâté' (liver and meat products), 'Frankfurter' type sausage and 'tête pressée' (head meat product in jelly). The dry cured products were sorted in raw ham (smoked or not smoked), 'lard' (smoked belly) and 'Filet de Saxe' (smoked pork loin). The dry fermented products were subdivided in 'Salami' type sausage (fine-grained, large diameter), semi-dried sausage (fine-grained, low diameter), 'Ardenne' sausage (irregular grain, low diameter), full dried sausage (coarse-grained, low diameter) and 'Chorizo'type sausage.

Methods. The analyses were applied to a 200 g ground and homogenized sample. The a_w was determined at 25°C using a Novasina Thermoconstanter TH200 a_w-meter measuring moisture of the air in a closed sample chamber when moisture equilibrium is obtained between the sample and the air in the chamber. Moisture content was determined by dessication to constant weight at 103°C according to the ISO 1442-1973 method. The NaCl content was evaluated on the basis of the chloride content determined by the Volhard method (ISO 1841-1981). The pH was measured directly in the ground sample according to the ISO 2917-1974 method with a Knick Portamess 912X pH meter equipped with a Ingold Lot 406-M6-DXK-57/25 combined electrode. *Enterobacteriaceae* were numbered in 39 of the 79 samples during storage by using the NF V-08-54 method (AFNOR, 1993) in order to evaluate the shelf life of the products.

RESULTS AND DISCUSSION

The characteristics of the physico-chemical analyses of the 79 products are summarized in the table 1. On the whole, the a_w was 0.960 ± 0.004 in the cooked products, 0.925 ± 0.019 in the raw cured products and 0.912 ± 0.024 in the dry fermented products. The a_w of the cooked products was only 0.2 to 0.3 lower than in fresh meat and similar to values reported for these products (Barraud and Grimault, 1980; Rödel, 1992). The 2 other categories are usually classified as intermediate-moisture foods ($0.600 < a_w < 0.910$). Only 4 dry cured products and 11 dry fermented products can be classified in that group. Nevertheless all the dry fermented products can be considered as conservable -they can be stored unrefrigerated- on the basis of the hurdle concept translated in the original 77/99 EEC hygiene directive and F.A.O. publications (1990), their a_w being lower than 0.95 and associated with a pH lower than 5.2 (Fig. 1). During a 10 weeks storage at 12°C, no growth of *Enterobacteriaceae* was detected in the 20 dry fermented products submitted to microbiological analysis. By contrast, there were no pH data lower than 5.2 in any of the dry cured products. Only 20% of the dry cured of the present trial can therefore be considered as conservable. This low proportion was rather surprising particularly for raw ham submitted to a several months drying process. The low proportion can also be related to the high moisture level which f.e. reached 58% in the raw ham. By contrast, the relatively high a_w was not related to a low NaCl content, 5.69% being not low when compared to the level of 5.5% observed by Fernandez-Salguero et al. (1994) in cured ham exhibiting 0.909 for a_w. Except for products submitted to a higher degree of dessication, raw ham is commonly stored refrigerated in Belgium. In such conditions, the development of microorganisms can be inhibited. The safety can be related to the absence of *Enterobacteriaceae* growth during a 13 weeks storage at 7°C (< 200 cfu/g in the 12 products which were submitted to a microbiological analysis). By contrast, in 4 of the 10 cooked products evaluated for the same parameter, a 4 log growth was detected during a 6-8 weeks storage at 4 or 7°C.

The effect of NaCl as depressor factor on a_w can be evaluated from the equation : a_w = [moles of water]/[moles of water + moles of Na^+ and Cl^- ions] (Barraud and Grimault, 1980). The difference between these theoretical a_w and actual a_w varied from +0.013 to +0.028 in the cooked products, from +0.016 to +0.043 in the dry cured products and from +0.018 to +0.059 in the dry fermented products. This high difference was not surprising because the equation is based on the hypothesis that all NaCl is dissociated. Nevertheless a higher prediction can be obtained from the regression calculated between the a_w and the NaCl/moisture ratio. When applied to the results of the 79 products of the present trial the equation was

$$a_w = 0.9845 - (0.0076 * {}^{\%NaCl}/_{Moisture})$$

With a correlation coefficient (R) of 0.957, it appeared that 92% of the a_w variation was attributed to the variation of the NaCl/Moisture ratio. The contribution of other solutes as a_w depressor factors can therefore be considered as low. The difference between the a_w calculated from the regression and the actual a_w of each of the 79 products varied from -0.006 to +0.010 in the cooked products, from -0.015 and +0.010 in the dry cured products and from +0.011 and +0.024 in the dry fermented products. These differences can be compared to similar differences observed between actual a_w and a_w calculated from the NaCl osmolality in intermediate moisture spanish products by Fernandez-Salguero et al. (1994).

CONCLUSION

In the present experiment, all dry fermented products and only 20% of the dry cured products can be considered as conservable on the basis of their a_w and pH. The dry cured products can be safe if stored at 7°C. In the whole experiment, the NaCl/Moisture content accounted for more than 90% of the variation of a_w. The theoretical a_w calculated from this ratio has to be considered as approximative because the error can reach 0.024.

LITERATURE

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Fig. 1. Water activity (a_w) and pH of 79 Belgian meat products

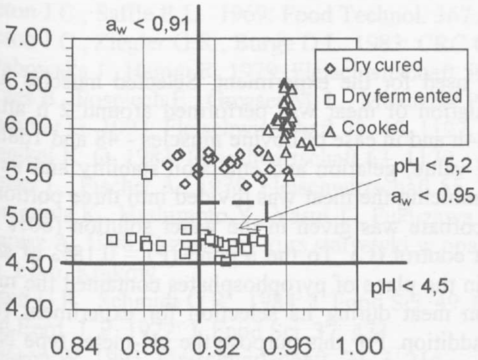

Fig. 2. a_w and $^{NaCl}/_{Moisture}$ ratio of 79 Belgian meat products

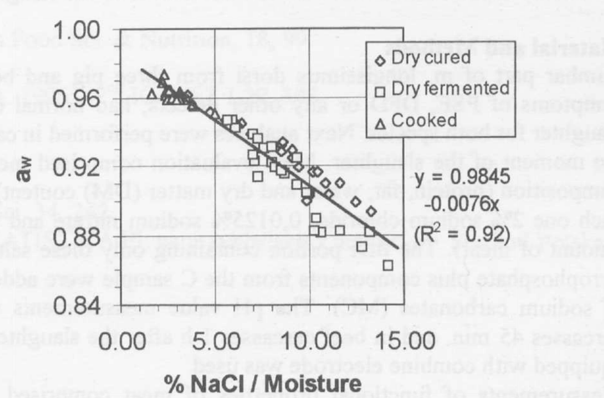

Table 1. Water activity (a_w) and some physico-chemical parameters of 79 Belgian meat products (mean ± standard deviation)

Product	N	a_w	Moisture (%)	NaCl (%)	NaCl/Moisture (%)	pH
Cooked products						
Cooked ham	8	0.962 ± 0.001	71.4 ± 2.5	1.88 ± 0.09	2.63 ± 0.17	6.07 ± 0.07
'Saucisson de jambon'	5	0.962 ± 0.002	62.2 ± 3.1	1.95 ± 0.17	3.13 ± 0.29	6.06 ± 0.07
'Pain de viande'	8	0.960 ± 0.001	67.4 ± 5.7	1.89 ± 0.13	2.81 ± 0.25	6.23 ± 0.28
'Pâté'	5	0.957 ± 0.002	54.0 ± 4.1	1.96 ± 0.24	3.63 ± 0.38	6.17 ± 0.11
'Frankfuter' type sausage	3	0.958 ± 0.013	54.6 ± 10.7	2.14 ± 0.50	4.12 ± 1.52	5.83 ± 0.14
'Boudin'	3	0.963 ± 0.001	62.5 ± 4.8	1.41 ± 0.31	2.27 ± 0.54	6.06 ± 0.52
'Tête pressée'	1	0.969	71.3	1.60	2.24	5.85
Dry cured products						
Raw ham	15	0.918 ± 0.015	58.1 ± 4.2	5.69 ± 1.02	9.82 ± 1.88	5.60 ± 0.12
'Lard'	2	0.943 ± 0.012	57.4 ± 7.2	3.74 ± 1.05	6.67 ± 2.67	5.63 ± 0.13
'Filet de Saxe'	3	0.951 ± 0.009	65.5 ± 3.5	3.35 ± 0.92	5.10 ± 1.34	5.48 ± 0.05
Dry fermented products						
'Salami' type sausage	12	0.923 ± 0.018	42.2 ± 6.4	3.30 ± 0.40	8.00 ± 1.58	4.70 ± 0.11
Semi dried sausage	8	0.917 ± 0.018	40.3 ± 6.0	3.30 ± 0.22	8.36 ± 1.49	4.76 ± 0.04
'Ardenne' sausage	3	0.872 ± 0.010	30.2 ± 3.0	4.01 ± 0.30	13.34 ± 0.74	4.76 ± 0.04
Full dried sausage	1	0.882	29.1	3.37	11.58	5.49
'Chorizo' type sausage	2	0.900 ± 0.025	39.0 ± 3.8	3.64 ± 0.13	9.39 ± 1.25	4.75 ± 0.05