PHYSICOCHEMICAL, TEXTURAL AND SENSORY CHARACTERISATION OF SOME SMOKED CHICKEN BREAST ASSORTMENTS AVAILABLE ON THE LOCAL MARKET

S.-M. Coșarcă (Dumitraș), B.-G. Anchidin*, D.-R. Manoliu, I. Gucianu, E.-I. Flocea, C.-M. Ciobotaru, T. Crăciunaș, M.-M. Ciobanu, P.-C. Boișteanu

"Ion Ionescu de la Brad" Iasi University of Life Sciences,
3 Mihail Sadoveanu Alley, 700490 Iasi, Romania

Abstract

Differences in processing and formulation can markedly shape the quality and consumer perception of commercial smoked chicken breast products. This study compared three commercial products, Caroli (CB1), Aldis (CB2), and Pikok (CB3), in terms of chemical composition, pH, water activity, instrumental colour, texture, hedonic response, QDA, and PCA. Significant differences were found for moisture, salt, protein, pH, and water activity, while colour was strongly influenced by measurement location. Texture differed in shear force, work of cutting, cohesiveness, springiness, gumminess, and chewiness. CB1 received the highest hedonic scores, including an overall acceptability of 8.60, and was characterized by stronger chicken and smoke notes and a firmer, more compact texture. PCA clearly separated the products, with F1 and F2 explaining 67.87% and 32.13% of the variance. Overall, the results revealed marked physicochemical, textural, and sensory differences among the products.

Key words**:** *smoked chicken breast; sensory analysis; texture profile analysis; physicochemical properties; consumer acceptance.*

INTRODUCTION

Poultry is the main driver of growth in global meat consumption, with the increase in demand attributed to white meat (Henchion et al., 2014). According to Whitton et al., 2021, poultry consumption has increased in most states, while beef and mutton consumption has decreased, between 2000 and 2019, in 35 countries monitored. Estimates of demand for animal-based foods indicate that this advantage will become more pronounced as incomes rise in low - and middle – income economies, with poultry meat capturing the largest share of this additional demand (Komarek et al., 2021). Within the carcass, the *musculus pectoralis* accounts for the largest share of this commercial value: it is the leanest portion with the highest protein density, and four decades of selection for breast yield have made it the primary raw material for the meat-processing industry (Petracci and Cavani, 2011).

At the same time, consumer preferences have shifted from whole carcasses to portioned, highly processed, and ready-to-eat products, and smoked chicken breast has become one of the most prominent categories in the deli section. Such products are not simply heat-treated steel: they are produced through a series of individual processes, each of which alters a different aspect of quality. Injection or immersion in brine introduces sodium chloride, nitrite,

*Corresponding author: bianca.anchidin@iuls.ro
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phosphates, and sugars; mixing or tumbling distributes these substances and extracts the myofibrillar proteins; the aging period allows for the redistribution of salt and water.; heat treatment sets the protein gel and, with it, the texture; and smoking deposits the volatile fraction responsible for the characteristic flavor and surface color (Cho and Choi, 2021; Chang et al, 2021). Because these processes interact, even small differences in the recipe or production parameters result in measurable differences in the composition, water content, colour, and texture of the finished slice (Fu and Kerr, 2020; Liu et al., 2026).

Most of the qualitative variation among salted and smoked chicken breast products can be attributed to a limited number of formulation variables, the mechanisms of which are well established. Sodium chloride and alkaline phosphates increase ionic strenght and shift the pH away from isoelectric point of myofibrillar proteins, thereby increasing WHC and, consequently, heat treatment yield, juiciness, and sliceability (Huff-Lonergan and Lonergan 2005; Molina et al., 2023). Salt, however, remains both the primary flavour carrier and the main nutritional vulnerability of processed meat products, which keeps the industry under pressure to reformulate without sacrificing functionality (Desmond, 2006; Wang et al., 2023; Hunter et al., 2022).

Smoking adds a second level of differentiation and, with it, a second trade-off. The phenolic and carbonyl fractions of wood smoke generate the flavour notes perceived as smoky and interact with the products surface, causing the characteristic darkening of colour, such that the wood species and the smoking regime directly shape the sensory profile (Saldaña et al., 2019; Chang et al., 2021).

Variability in raw materials overlaps with variability in formulation. Fast-growing broiler hybrids have led to a high incidence of breast muscle abnormalities (white striping, wooden breast and spaghetti meat), which alter the chemical composition, increase collagen and fat content, reduce protein content and diminish WHC (Petracci et al., 2015; Soglia et al., 2016; Petracci et al., 2019; Bošković Cabrol et al. 2024). These defects reduce brine absorption and increase losses during heat treatment, precisely the proprieties on which injected and smoked products depend (Mudalal et al., 2015), and shift both the instrumental texture and the descriptively assessed texture of the marinated breast towards tougher and less cohesive profiles (Aguirre et al., 2018).

However, most published studies compare experimental formulations, genotypes or growing systems under controlled conditions (Funaro et al., 2014), and comparative data om commercial varieties actually available on store shelves remain limited. Market-level analyses of other product categories show that compositional profiles can differ substantially between countries and retail chains (Filip et al., 2025), and recent research in Romania has focused primarily on the reformulation and tenderization of pork products (Ciobotaru et al., 2026), rather than on the characterization of smoked poultry products already on the market. In practice, consumers rely solely on the information on the label and are unable to assess the extent to which products with similar names differ in composition, color, or texture.

The study aimed to characterize and compare three commercial varieties of smoked chicken breast in terms of chemical composition, physicochemical properties, color, instrumental texture, and sensory profile, as well as to identify, through sensory analysis, the attributes that determine product differentiation and consumer acceptability.

MATERIAL AND METHOD

The chemical composition of the commercial smoked chicken breast samples was determined using an automatic FoodCheck analyzer (Bruins Instruments GmbH, KPM Analytics, Germany), and the

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results for moisture, fat, protein, and salt were expressed as percentages. Sample pH was measured by direct insertion of a meat-specific penetration electrode connected to a digital pH meter (HI98163, Hanna Instruments, Nușfalău, Romania). Water activity (a_w) was determined using a Schaller water activity meter.

Instrumental colour was measured using a Konica Minolta CR-410 colorimeter (Konica Minolta, Inc., Tokyo, Japan), under a D65 illuminant and a 10° standard observer. Measurements were performed on both the external surface and the internal section of the samples, and the colour parameters were expressed as L*, a*, b*, chroma (C*) (1), and hue angle (h*) (2).

$$\text{Chroma (C*)} = \sqrt{(a^*)^2 + (b*)^2} \quad (1)$$

$$\text{Hue angle (h*)} = tan^{-1} \times b^*/a^* \quad (2)$$

Instrumental texture was evaluated using a TA1+1K Plus texturometer (Ametek, Inc., USA). The analysis included Warner–Bratzler shear testing, expressed as toughness and work of cutting, as well as texture profile analysis (TPA), including hardness, cohesiveness, springiness, gumminess, and chewiness.

Sensory evaluation was conducted by 15 experienced assessors and included both hedonic analysis and quantitative descriptive analysis (QDA). The hedonic test was used to assess product acceptance in terms of appearance, odour, taste, texture, and overall acceptability, while QDA was applied to characterize the sensory profile of the samples using predefined descriptors. The samples were coded with random three-digit numbers and presented in randomized order under controlled laboratory conditions. Water and plain bread were provided between samples for palate cleansing. Principal component analysis (PCA) was subsequently applied to the descriptive sensory data to identify the main attributes contributing to sample differentiation.

Statistical analysis was performed using XLSTAT software (Lumivero, Denver, CO, USA). All physicochemical, colour, and instrumental texture measurements were performed in triplicate (n = 3). Physicochemical and texture data were analysed by one-way ANOVA followed by Tukey's HSD test. Colour data were analysed considering the effects of sample, measurement location (surface vs. internal section), and their interaction. Sensory evaluation involved 15 assessors (n = 15); QDA data were analysed using a model including sample and evaluator effects, followed by Tukey's HSD test for sample comparisons. Results were expressed as mean ± SD, with statistical significance set at $p < 0.05$. PCA was applied to the descriptive sensory data to visualize sample differentiation and relationships among sensory attributes.

RESULTS AND DISCUSSIONS

The physico-chemical characteristics revealed significant differences between the three commercial products for most of the parameters analysed (Table 1). Significant differences ($p < 0.05$) between samples were recorded for 5 of 6 parameters determined, namely moisture content ($p = 0.028$*), salt content ($p < 0.001$***), protein content ($p = 0.011$*), pH ($p < 0.001$***) and water activity ($p < 0.001$***), indicating that the products from the three producers have distinct composition and physico-chemical proprieties. The only parameter for which no significant differences were found was fat content ($p = 0.166$), with values falling within a narrow range (1.80 – 2.02%), typical of products made from chicken breast, which are characterised by a low lipid content. The low standard deviations recorded for all parameters (ranging from ±0.001 for a_w to ±0.33 for

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moisture) confirm good repeatability of the analytical determinations and a high degree of homogeneity within each batch analysed.

The most pronounced differences between the samples concerned salt content, pH, and water activity, parameters for which the Tuckey's HSD test separated all three products into distinct significance groups (a, b, c). Sample CB1 stood out for having the highest moisture content (73.38±0.33%; p = 0.028*) and the lowest pH value (6.247±0.01; p < 0.001***), associated with a moderate salt content (1.98±0.10%). Sample CB2 had the highest salt content (2.48±0.09%; p < 0.001***) and protein content (21.64±0.13%; p = 0.011*), correlated with the lowest moisture content (72.67±0.12%), suggesting a higher proportion of dry matter and, consequently, a different technological yield compared with the other two products; this sample also had the highest water activity value (0.947±0.002; p < 0.001***). Sample CB3 stood out for having the highest pH (6.680±0.06; p < 0.001***), alongside the lowest salt content (1.69±0.09%) and the lowest water activity (0.933±0.002; p < 0.001***), whilst the protein content was comparable to that sample CB1 (20.90±0.27% and 20.93±0.24% respectively).

The pH values, ranging from 6.247 to 6.680, and the water activity values, ranging from 0.933 to 0.947, place all three products in the category of high-moisture meat preparations, for which microbiological stability is not ensured by reducing a_w, but through heat treatment, smoking and maintaining the cold chain. The variation in salt content , ranging from 1.69% to 2.48% reflects differences in salting recipes between producers and represents the physico-chemical factor with the greatest potential to influence the sensory profile and water-binding capacity of the final product.

Table 1. Physicochemical characteristics of commercial smoked chicken breast products

Parameter	CB1	CB2	CB3	*p*-value
Moisture (%)	73.38 ± 0.33^{a}	72.67 ± 0.12^{b}	72.70 ± 0.31^{b}	0.028*
Fat (%)	1.80 ± 0.13^{a}	2.02 ± 0.13^{a}	1.98 ± 0.13^{a}	0.166ns
Salt (%)	1.98 ± 0.10^{b}	2.48 ± 0.09^{a}	1.69 ± 0.09^{c}	<0.001***
Protein (%)	20.93 ± 0.24^{b}	21.64 ± 0.13^{a}	20.90 ± 0.27^{b}	0.011*
pH	6.247 ± 0.01^{c}	6.390 ± 0.04^{b}	6.680 ± 0.06^{a}	<0.001***
aw	0.937 ± 0.001^{b}	0.947 ± 0.002^{a}	0.933 ± 0.002^{c}	<0.001***

Note: *Values are presented as mean ± SD (n = 3). Different superscript letters within the same row indicate significant differences according to Tukey's HSD test (p < 0.05). * p < 0.05; ** p < 0.01; *** p < 0.001; ns, not significant. CB1 = Caroli, CB2 = Aldis, CB3 = Pikok.*

Instrumental colour analysis revealed that the measurement location was the main source of variation in the colour parameters, with this effect being significant for all five parameters measured (Table 2). In contrast, the effect of the sample was insignificant for most parameters: L* (p = 0.228ns), a* (p = 0.098ns), b* (p = 0.201ns) and h° (p = 0.449ns), with significant differences between products being observed only for chroma C* (p = 0.010*). The sample × measurement location interaction was significant for lightness (p = 0.008**) and for the hue angle (p = 0.013*), which indicates that the ranking of the products is not consistent across the surface and in cross-section, and that differences between producers manifest differently depending on the area assessed.

The contrast between the surface and the cross-section was pronounced for all three CIELab coordinates. The surface of the products exhibited significantly lower values of lightness (56.46 – 60.36 compared with 73.86 – 77.89 in the cross section) and much higher values of the a* (21.33–26.97 compared with 7.45–8.14) and b* (53.10–56.53 compared with 12.13–15.16), with a

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chroma C* approximately four times higher (57.31–61.79 compared with 14.24–16.96). This pattern corresponds to the specific appearance of smoked products, in which the deposition of the phenolic and carbonyl components of smoke, together with surface Maillard reactions, results in an intense, saturated colour ranging from reddish-brown to orange, whilst the cross-section retains the light pink, slightly desaturated colour characteristic of heat-treated pectoral muscle. The larger standard deviations recorded on the surface (up to ±3.82 for h° and 3.12 for a*), compared with those in the cross-section (±0.13 - ±2.01), reflect the non-uniformity of smoke deposition and superficial heat treatment, whilst the internal colour is much more uniform.

The differences between products were evident almost exclusively at the cross-sectional level, where, at the surface, none of the parameters significantly distinguished the samples. In cross-section, sample CB2 stood out due to its highest brightness (77.89±1.18; p = 0.008** for interaction), the highest values for the b* component (15.16±1.23) and the C* chroma (16.96±1.14), as well as the lowest hue angle (26.66±1.85), a profile that describes a lighter and more saturated yellowish colour. Samples CB1 and CB3 formed a homogeneous group for b*, C* and h° in this section.; however, CB1 stood out due to the highest value of the red a* component (8.14±0.21), significantly higher than those recorded for CB2 (7.59±0.27) and CB3 (7.45±0.09). It should be noted that the significance letters were assigned following comparisons carried out within the same measurement location; therefore, the separation of the samples within the section, given that the main effect of the sample was not significant, is the result of the significant sample × measurement location interaction; the difference between the products are detectable within the product but are masked on the surface by the colour uniformity induced by smoking.

Table 2. Instrumental colour parameters of commercial smoked chicken breast products according to sample and measurement location

Parameter	Location	CB1	CB2	CB3	*p*-value Sample	*p*-value Location	*p*-value Sample × Location
L*	Surface	58.43 ± 1.02^{a}	56.46 ± 1.89^{a}	60.36 ± 2.55^{a}	0.228ns	<0.001***	0.008**
	Section	73.86 ± 0.68^{b}	77.89 ± 1.18^{a}	75.32 ± 1.64^{ab}			
a*	Surface	24.86 ± 3.10^{a}	26.97 ± 2.99^{a}	21.33 ± 3.12^{a}	0.098ns	<0.001***	0.132ns
	Section	8.14 ± 0.21^{a}	7.59 ± 0.27^{b}	7.45 ± 0.09^{b}			
b*	Surface	56.53 ± 0.65^{a}	53.90 ± 2.91^{a}	53.10 ± 3.47^{a}	0.201ns	<0.001***	0.100ns
	Section	12.42 ± 0.37^{b}	15.16 ± 1.23^{a}	12.13 ± 0.79^{b}			
C*	Surface	61.79 ± 1.61^{a}	60.36 ± 1.20^{a}	57.31 ± 2.67^{a}	0.010*	<0.001***	0.077ns
	Section	14.85 ± 0.42^{b}	16.96 ± 1.14^{a}	14.24 ± 0.62^{b}			
h°	Surface	23.70 ± 2.55^{a}	26.63 ± 3.82^{a}	21.96 ± 3.80^{a}	0.449ns	<0.001***	0.013*
	Section	33.22 ± 0.13^{a}	26.66 ± 1.85^{b}	31.61 ± 2.01^{a}			

Note: *Values are presented as mean ± SD (n = 3). Different superscript letters within the same location and parameter indicate significant differences among samples according to Tukey's HSD test (p < 0.05). p-values refer to the effects of sample, measurement location, and their interaction. * p < 0.05; ** p < 0.01; *** p < 0.001; ns, not significant. CB1 = Caroli; CB2 = Aldis; CB3 = Pikok.*

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The colour data therefore reveal a broadly similar external profile for the three commercial products, with the smoking process standardising the external colour, whilst differences in recipe and production methods remain visible in cross-section, where CB2 has the lightest and least reddish internal appearance, and CB1 the most intense pink.

Table 3 presents the instrumental texture characteristics, which showed significant differences among the three commercial products for 6 of the 7 parameters measured, namely shear force ($p = 0.001$**), work of cutting ($p < 0.001$***), cohesiveness ($p = 0.009$**), springiness = 0.014*), gumminess ($p = 0.014$*) and chewiness ($p = 0.005$**). The only parameter for which the differences did not reach the significance threshold was hardness ($p = 0.064$ns), although the values varied over a relatively wide range, from 13.90±1.87 N in CB2 to 18.47±2.65 N in CB1.

The Warner-Bratzler test clearly distinguished sample CB2 from the other two products, as it exhibited both the lowest shear force (6.20±0.36 N; $p = 0.001$**) and the lowest work of cutting (96.62±2.81 N·mm; $p < 0.001$***), values that were 27-37% lower than those recorded for CB1 (8.50±0.68 N and 171.00±10.56 N·mm, respectively) and in CB3 (8.81 ±0.34 N and 152.68 ±10.05 N·mm, respectively), which formed a homogenous group. The concordance between these two parameters confirms that sample CB2 exhibits the lowest resistance to transverse sectioning of muscle fibers, making it, from an instrumental standpoint, the most tender product, while the work of cutting, a parameter that integrates the entire force-strain profile, not just the maximum value, further highlights this distinction.

In the analysis of the texture profile, sample CB1 stood out with the highest values for all parameters measured: cohesiveness (0.20 ±0.02; $p = 0.009$**), springiness (0.850 ±0.04; $p = 0.014$*), gumminess (3.62 ±0.52 N; $p = 0.014$*) and chewiness (3.07 ±0.35 N; $p = 0.005$**), a profile that describes a well-bound structure with good recovery capacity after compression. At the opposite end of the spectrum, sample CB3 exhibited the lowest cohesiveness (0.15 ±0.01) and the lowest springiness (0.703 ±0.04), significantly lower than the values recorded for CB1, while CB2 occupied an intermediate position for these two parameters (0.17±0.01 and 0.763 ±0.05, respectively), showing no significant difference from either the other samples. For the derived parameters, gumminess and chewiness, samples CB2 and CB3 formed a single group with similar values (2.37 ±0.40 N and 2.54 ±0.13 N for gumminess, and 1.82 ±0.40 N and 1.79 ±0.19 N for chewability, respectively), which were significantly lower than those of sample CB1. The fact that the derived parameters became significant despite the statistically insignificant harness is explained by the way they are calculated: gumminess results from the product of hardness and cohesiveness whereas chewiness is obtained as the product of gumminess and springiness, so that the real, though moderate, differences in hardness accumulate with those in cohesiveness and springiness, amplifying the differentiation between the products.

Finally, the two methods complement each other: CB2 is the most tender under shear, CB1 has the most compact and springy structure, and CB3 combines high shear resistance with the lowest cohesiviness.

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Table 3. Instrumental texture characteristics of commercial smoked chicken breast products

Method	Parameter	CB1	CB2	CB3	*p*-value
Warner–Bratzler	Shear force (N)	8.50 ± 0.68^{a}	6.20 ± 0.36^{b}	8.81 ± 0.34^{a}	0.001**
	Work of cutting (N·mm)	171.00 ± 10.56^{a}	96.62 ± 2.81^{b}	152.68 ± 10.05^{a}	<0.001***
Texture profile analysis (TPA)	Cohesiveness	0.20 ± 0.02^{a}	0.17 ± 0.01^{ab}	0.15 ± 0.01^{b}	0.009**
	Hardness (N)	18.47 ± 2.65^{a}	13.90 ± 1.87^{a}	16.94 ± 0.54^{a}	0.064ns
	Springiness	0.850 ± 0.04^{a}	0.763 ± 0.05^{ab}	0.703 ± 0.04^{b}	0.014*
	Gumminess (N)	3.62 ± 0.52^{a}	2.37 ± 0.40^{b}	2.54 ± 0.13^{b}	0.014*
	Chewiness (N)	3.07 ± 0.35^{a}	1.82 ± 0.40^{b}	1.79 ± 0.19^{b}	0.005**

Note: *Values are presented as mean ± SD (n = 3). Different superscript letters within the same row indicate significant differences according to Tukey's HSD test (p < 0.05). * p < 0.05; ** p < 0.01; *** p < 0.001; ns, not significant. CB1 = Caroli, CB2 = Aldis, CB3 = Pikok.*

The sensory evaluation highlighted distinct differences in the perception and acceptance of the three commercial chicken breast products, as reflected by both the hedonic scores and the descriptive sensory profiles.

The hedonic evaluation revealed clear differences among the three commercial smoked chicken breast products (Fig. 1). CB1 consistently received the highest scores for all sensory categories, with particularly high ratings for appearance (8.53), odour (8.40), taste (8.40), and overall acceptability (8.60), while texture was slightly lower (7.67) but still indicative of a high level of appreciation. In comparison, CB2 and CB3 showed markedly lower and relatively similar hedonic profiles. CB2 obtained scores of 5.93 for appearance, 5.20 for odour, 5.80 for taste, and 5.53 for texture, whereas CB3 showed slightly higher ratings for appearance (6.13), odour (5.47), taste (5.93), and texture (5.80). Thus, the main differentiation of CB1 was not restricted to overall acceptability but was supported by consistently higher appreciation of its visual, olfactory, gustatory, and textural characteristics. The scores recorded for CB2 and CB3 remained around or above the midpoint of the nine-point hedonic scale, indicating moderate acceptance rather than sensory rejection.

This pattern is consistent with studies on processed and smoked poultry products showing that consumer acceptance is strongly influenced by the combined perception of appearance, flavour, aroma, juiciness, and texture rather than by a single sensory characteristic (Tura et al., 2024; Samant et al., 2016).



Fig. 1. Hedonic sensory evaluation of commercial smoked chicken breast products

The QDA results showed a clear discriminatory effect of the sample for most sensory attributes, whereas the evaluator effect was generally less pronounced (Table

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4). Significant differences ($p < 0.05$) among products were observed for 20 of the 25 descriptors, indicating that the three commercial chicken breast products exhibited distinct sensory profiles. In contrast, the evaluator effect was non-significant for the majority of attributes (15 of 25), suggesting a relatively good agreement within the trained panel and an adequate reproducibility of the sensory assessment. Significant evaluator-related variability was mainly observed for creamy-white colour ($p = 0.036$*), lactic notes ($p < 0.001$***), ham flavour (p = 0.014*), salty taste ($p = 0.019$*), poultry pâté flavour ($p = 0.010$*), aftertaste persistence ($p = 0.033$*), and several texture-related descriptors, including firmness ($p = 0.002$**), friability ($p = 0.033$*), fibrousness ($p = 0.028$*), and wet-mass sensation ($p = 0.036$*).

The greatest differentiation among samples concerned colour characteristics, smoke and poultry-related odour/flavour notes, and texture. CB1 was characterized by higher scores for white-pink colour ($p < 0.001$***), characteristic chicken odour ($p < 0.001$***) and flavour ($p < 0.001$***), smoke odour ($p < 0.001$***), compactness ($p < 0.001$***), elasticity ($p = 0.002$**), and firmness ($p = 0.002$**). CB2 was distinguished particularly by pronounced poultry pâté odour and flavour (both $p < 0.001$***) and a higher perception of visible muscle fibres ($p < 0.001$***). CB3 showed the highest scores for friability ($p = 0.004$**) and wet-mass sensation ($p < 0.001$***) and the lowest compactness ($p < 0.001$***). The significant evaluator effect observed for several texture descriptors, particularly firmness ($p = 0.002$**), friability ($p = 0.033$), and fibrousness ($p = 0.028$*), may reflect greater heterogeneity in texture perception, since structural differences within the samples could result in slightly different responses depending on the portion assessed.

Overall, CB1 showed the most consistent textural profile, with comparatively lower dispersion for several descriptors, particularly compactness, fibrousness, and firmness, whereas CB2 and CB3 displayed greater variability in texture perception.

Table 4. Quantitative descriptive analysis (QDA) scores of commercial smoked chicken breast products and effects of sample and evaluator

Attribute	CB1	CB2	CB3	*p*-value Sample	*p*-value Evaluator
Appearance					
Appearance of intact muscle portion	8.67 ± 0.72^{a}	7.73 ± 1.79^{ab}	7.00 ± 1.77^{b}	0.028*	0.770ns
Surface gloss	7.47 ± 1.25^{a}	6.47 ± 1.06^{a}	7.53 ± 1.77^{a}	0.077ns	0.440ns
Colour uniformity	7.80 ± 1.42^{a}	6.07 ± 1.39^{b}	7.33 ± 1.50^{a}	0.003**	0.107ns
Visible muscle fibres	5.27 ± 1.83^{b}	7.73 ± 1.03^{a}	6.27 ± 1.44^{b}	<0.001***	0.422ns
Creamy-white colour	2.33 ± 1.50^{b}	4.93 ± 1.71^{a}	3.47 ± 1.55^{b}	<0.001***	0.036*
White-pink colour	8.13 ± 0.83^{a}	3.53 ± 1.36^{b}	7.13 ± 0.99^{a}	<0.001***	0.656ns
Odour					
Characteristic chicken meat odour	8.27 ± 1.33^{a}	5.00 ± 1.81^{b}	4.53 ± 2.26^{b}	<0.001***	0.927ns
Smoke odour	7.00 ± 1.07^{a}	2.93 ± 1.53^{b}	3.27 ± 1.67^{b}	<0.001***	0.387ns
Spice odour	6.80 ± 1.21^{a}	5.27 ± 1.91^{b}	4.33 ± 1.40^{b}	<0.001***	0.623ns

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Attribute	CB1	CB2	CB3	*p*-value Sample	*p*-value Evaluator
Lactic notes	2.20 ± 2.04^{b}	2.60 ± 2.38^{b}	4.13 ± 2.36^{a}	<0.001***	<0.001***
Poultry pâté odour	1.33 ± 1.05^{c}	7.73 ± 1.33^{a}	3.47 ± 1.73^{b}	<0.001***	0.108ns
Taste and flavour					
Characteristic chicken meat flavour	8.33 ± 1.05^{a}	6.87 ± 2.23^{b}	5.93 ± 1.03^{b}	<0.001***	0.534ns
Ham flavour	6.40 ± 1.64^{a}	5.00 ± 2.04^{b}	3.53 ± 1.41^{c}	<0.001***	0.014*
Spice flavour	6.20 ± 1.57^{a}	5.00 ± 2.04^{a}	5.53 ± 1.85^{a}	0.135ns	0.061ns
Salty taste	5.53 ± 1.13^{a}	4.27 ± 1.28^{b}	6.33 ± 1.50^{a}	<0.001***	0.019*
Poultry pâté flavour	1.67 ± 1.40^{c}	6.60 ± 2.03^{a}	3.33 ± 1.84^{b}	<0.001***	0.010**
Aftertaste persistence	3.80 ± 1.32^{a}	5.07 ± 2.31^{a}	4.27 ± 1.44^{a}	0.074ns	0.033*
Atypical aftertaste	1.07 ± 0.26^{a}	1.60 ± 1.12^{a}	2.13 ± 2.07^{a}	0.099ns	0.269ns
Texture					
Firmness	5.27 ± 1.91^{a}	2.80 ± 2.46^{b}	3.73 ± 2.63^{ab}	0.002**	0.002**
Juiciness	6.60 ± 1.59^{a}	5.07 ± 1.53^{b}	5.93 ± 1.22^{ab}	0.032*	0.649ns
Friability	3.73 ± 2.25^{ab}	2.93 ± 2.34^{b}	5.47 ± 2.29^{a}	0.004**	0.033*
Fibrousness	4.00 ± 1.60^{a}	5.07 ± 2.19^{a}	5.00 ± 2.14^{a}	0.163ns	0.028*
Compactness	8.13 ± 0.99^{a}	7.07 ± 1.22^{a}	5.53 ± 1.73^{b}	<0.001***	0.605ns
Elasticity	6.40 ± 1.84^{a}	4.00 ± 1.96^{b}	5.60 ± 1.72^{a}	0.002**	0.187ns
Wet mass sensation	2.33 ± 1.59^{b}	5.73 ± 0.88^{a}	6.33 ± 1.29^{a}	<0.001***	0.036*

Note: *Values are presented as mean ± SD (n = 15). Different superscript letters within the same row indicate significant differences among samples according to Tukey's HSD test. (p < 0.05). * p < 0.05; ** p < 0.01; *** p < 0.001; ns, not significant. The ANOVA model included Sample and Evaluator effects. CB1 = Caroli, CB2 = Aldis, CB3 = Pikok.*

Taken together, the hedonic and QDA results revealed a clear and coherent sensory pattern across the three products. CB1, which achieved the highest consumer ratings for appearance, odour, taste, texture, and overall acceptability, was also distinguished descriptively by a more intense white-pink colour, stronger characteristic chicken and smoke notes, and a firmer, more compact and elastic texture. By contrast, CB2 and CB3 showed lower hedonic scores and sensory profiles associated with more pronounced poultry pâté notes, greater friability and wet-mass sensation, together with reduced compactness. The consistency between hedonic preference and the QDA profile indicates that consumer acceptance was linked to the combined contribution of visual, aromatic, and textural characteristics.

This relationship was further supported by PCA (Fig. 2), which explained 100% of the total variance (F1 = 67.87%; F2 = 32.13%) and clearly differentiated the three products according to their sensory attributes. The position of CB1 in close proximity to the vectors corresponding to characteristic chicken meat odour and flavour, smoke odour, spice odour and

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flavour, firmness, compactness, elasticity, juiciness, colour uniformity, and pinkish-white hue indicates a strong association with these attributes. CB2 was located closer to poultry pâté odour and flavour, creamy-white hue, visible muscle fibers, and aftertaste persistence, suggesting that these descriptors were more characteristic of this product. CB3 was positioned near friability, salty taste, dairy notes, atypical aftertaste, wet-mass sensation, and fibrousness, indicating a stronger relationship with these sensory perceptions. The relatively small angles between several attribute vectors, such as firmness, compactness, elasticity, and chicken meat-specific flavour, also suggest positive relationships among these descriptors.

Overall, the PCA configuration was consistent with the QDA and hedonic results, as CB1 was associated with the sensory characteristics that accompanied its higher consumer acceptance, whereas CB2 and CB3 were related to attributes corresponding to their distinct and less preferred sensory profiles.

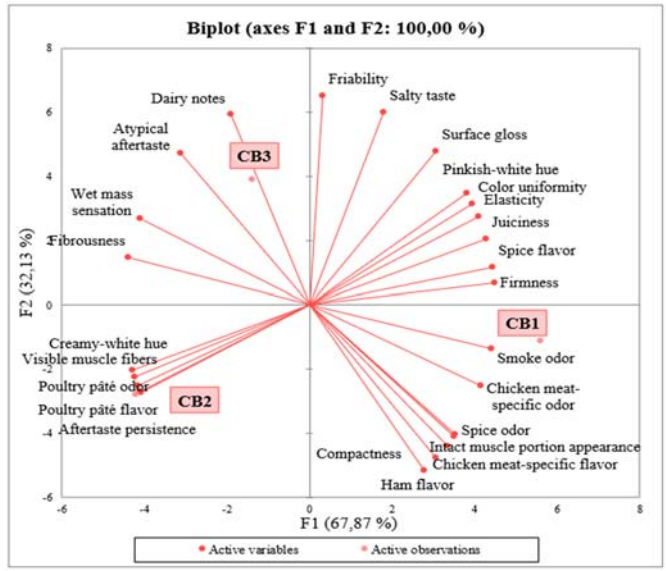


Fig. 2. Principal component analysis (PCA) biplot of the QDA sensory attributes of commercial smoked chicken breast products

CONCLUSIONS

A comparison of the three commercial varieties of chicken smoked breast confirmed the existence of significant differences between the products for most of the evaluated indicators: 5 out of 6 physicochemical parameters, 6 out of 7 instrumental texture parameters, and 20 out of 25 sensory descriptors. Although the products belong to the same commercial category and are perceived by consumers as equivalent, differences in recipe and production technology.

Smoking standardies the external colour - the effect of the measurement location was significant for all five colour parameters ($p < 0.001$***), with differences between producers remaining visible only in cross-section , where CB2 displayed the lightest appearance ($L^* = 77.89$) AND CB1 the most intense pink hue ($a^* = 8.14$). Instrumentally, CB2 proved to be the most tender under shear (6.20 N; 96.62 N·mm), whereas CB1 was the most compact and cohesive (cohesiveness 0.20; springiness 0.850). From a sensory standpoint, CB1

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achieved the highest hedonic scores (overall acceptability 8.60), associated with its white-pink colour, characteristic chicken and smoke notes, and firm texture, while CB2 and CB3 remained at a level of moderate acceptance (5.20 – 6.13), being characterised by poultry paté notes, friability and wet-mass sensation.

The convergence between methods was confirmed in the case of CB3, in which the high sear force (8.81 N)and the lowest cohesiveness (0.15) corresponded to the highest friability (5.47) and the lowest compactness (5.53) perceived by the sensory panel. Conversely, salty taste did not follow the chemically determined salt content: CB3 with only 1.69% NaCl, was perceived as the saltiest (6.33), whereas CB2, with 2.48%, was perceived as the least salty (4.27).

Extending the research to multiple batches over the shelf life, as well as incorporating lipid oxidation indicators and protein structure analysis, would help to clarify the mechanisms underlying the differences observed. The study confirms, however, that products marketed under the same name exhibit distinct physicochemical, textural and sensory profiles, and their integrated characterisation provides an objective basis for both technological optimisation and consumer choice.

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