POULTRYNSECT

D 3.5 Report on meat sensory analysis

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Abbreviations	
BSF	Black Soldier Fly
DA	Descriptive Analysis
LL	Live Larvae

Content

Introduction:

The POULTRYNSECT Work Package 3 “Laboratory and Sensorial Analyses” aims to evaluate the impact of Black Soldier Fly (BSF) live larvae inclusion as feed ingredient in chicken diet on chicken health and meat quality. Animal welfare and health affect many metabolic processes, which may impact meat quality after slaughter (Petracci, Bianchi, & Cavani, 2010). Differences in feed composition may also be translated to differences in chemical composition of meat and thus changes in sensory attributes. The assessment of bird`s health (D3.6 and 3.7) and the meat laboratory analyses chicken breast filets (D3.3) will be compiled in separate reports. This Deliverable (3.5) reports the meat sensorial analyses, colour and cooking loss measurement preliminary results obtained from the two in vivo feeding trials performed on Label Naked Neck and Bianca di Saluzzo chicken respectively.

Material and Methods

1. Material and Methods

1.1 First trial Experimental Design

The first trial consists of a factorial experiment based on two chicken dietary treatments (C=conventional diet, L=larvae-based diet) and sex (M=male, F=female). A total of 12 chicken breasts were considered for sensory meat evaluation, three for each breast type (CF, CM, LF, LM).

From each slaughtered bird, the left breast was shipped to Laboratory of the Norwegian Institute of Food, Fisheries and Aquaculture Research, Nofima (Norway), for the quali-quantitative meat analysis. Instead, the right side of each breast was subjected to sensory evaluation at Sensory Lab of the Institute for Bioeconomy of the Italian National Research Council, IBE-CNR, Bologna. At IBE Lab., color (CIELab) and drip loss after cooking were also measured (**Tab. 1 and 2**). Color determination was carried out using a Minolta Colorimeter (CM CR400, Minolta Co., Osaka, Japan), three measurements for each breast samples were taken. Drip loss was measured calculating the difference of raw and cooked weights using a common household scale.

1.2 Second trial Experimental Design

Like the first trial, after the slaughter the left breasts were shipped to Laboratory of the Norwegian Institute of Food, Fisheries and Aquaculture Research, Nofima (Norway), for the quali-quantitative meat analysis. Instead, the right side of each breast was subjected to sensory evaluation at Sensory Lab of the Institute for Bioeconomy of the Italian National Research Council, IBE-CNR, Bologna, at IBE Lab. Color (CIELab) and cooking loss after boiling were also measured.

In this case, the whole experiment consists of two separate analyses divided on the bases of slaughtered age of the chickens (150 and 180 days). On the 10th of November were tested the samples related to the animals slaughtered at 150 days of age while on 11 November those related to 180 days.

In this case, the samples of each slaughtering age belonged to the same two different dietary treatments as follows: commercial feed (MC) and live larvae based feed (LV). A total of 24 chicken breasts, six breasts for each dietary treatment and age, were considered for sensory meat evaluation, color, and cooking loss measurement.

1.3 Sample preparation

The procedure was identical for each trial. Chicken breasts were received in vacuum packed PA/PE bags and stored for a night at a temperature of 4°C. The cooking protocol was to boil chicken breasts in vacuum packs at low temperatures to best preserve sensorial properties. Hence, vacuum packed breasts were boiled in a water bath at a range temperature of 75 - 85 °C for 40 minutes using induction plates (initially set at 85 °C to maintain the temperature at the time of cold bags immersion and after ten minutes the plates were set to 75 °C). When cooking was completed the internal temperature of a chicken breast was measured at around 75 °C.

A)  B)  C) 

Fig. 1. A) Water temperature detection; B) cooking phase; C) detection of meat core temperature.

After cooling, the breasts were deprived of the terminal parts, which could influence the taste due to their different composition (fat, presence of collagen). Hence, samples from the central part of the muscle were served to the judges at temperature of 20 °C.

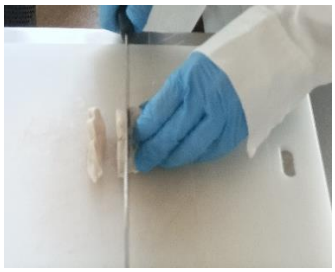
 

Fig. 2. Cut and samples preparation for sensory evaluation.

1.4 Color and cooking loss measurement

Before boiling, the raw weight of the samples was taken. Color determination was carried out using a Minolta Colorimeter (CM CR400, Minolta Co., Osaka, Japan), three measurements for each cooked breast sample were taken. Cooking loss was measured by calculating the difference between raw and boiled breasts weights taken with a common household scale **(Fig. 3).**

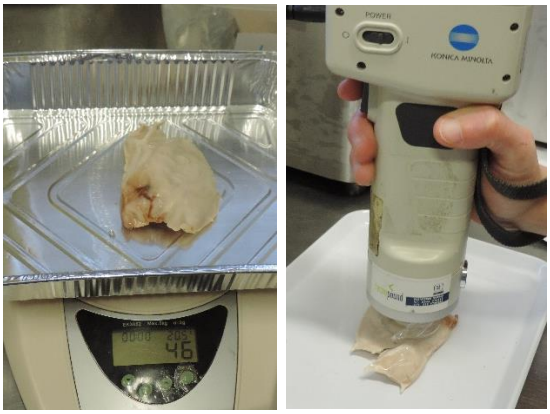


Fig. 3. Weight and color measurement.

1.5 Sensory evaluation

Sensory evaluation was executed on:

- n. 12 chicken breasts, three for each dietary treatment (CF, CM, LF, LM) for the 1st trial.

- n. 24 chicken breasts for each dietary treatment and for the two slaughtered ages (MC, LV at 150 and 180 days respectively) for the 2nd trial.

Sensory descriptive analysis (DA) was performed by 10 trained judges (6 females and 4 males, age 30-50), experts in sensory descriptive evaluation and in the use of the sensorial software used to collect data. Attributes to be used in this study were collected from literature on poultry meat and confirmed during the first trial of this project. Prior to the first sensory anal, judges received a short training conducted on commercial feed samples (MC) to familiarize again with chicken sensory descriptors.

Descriptive analysis was made in order to define sensorial profile of each types and to detect possible differences among the dietary treatments within the age groups. Judges performed sensory analysis at appropriate temperature conditions, in individual booths with notebooks equipped with a specific software for sensory data acquisition (FIZZ Biosystèmes, France), according with the standard protocol UNI 8589:1990. Test was carried out in duplicate, under the conditions described in the standard UNI 13299:2016 for the descriptive analysis (DA) by using intensity scales (ISO 8586:2012). Samples were distributed to the judges, coded with three-digit numbers and presented randomly. Mineral water was distributed to the judges to clean their mouth between samples.

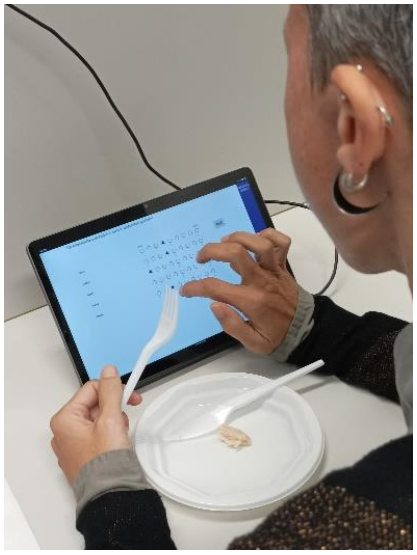


Fig. 4. An expert judge executing the descriptive analysis. For DA test judges were requested to indicate for each sample the relative intensity of sensory attributes using a nine-points intensity scale (1 = hardly perceptible; 9 = very intense).

Results

2. Results

2.1 Statistical analysis

Results were statistically elaborated using R version 4.1.1 (© 2019, The R Foundation for Statistical Computing). Color measurements, cooking loss measurements and sensorial profiles were analyzed through the ANOVA and post hoc test (Tukey's HSD).

2.2 Color and cooking loss

First trial results

Color and cooking loss of the breasts after cooking were analyzed (**Tab. 1 and 2**). Results showed differences on chicken sex. CF and LF, respectively female raised on conventional and larvae-based diet, presented lower weight compared to male breasts, probably due to animal dimension. However, no significant differences were found in mean percentages of drip loss despite the females lose more liquid after cooking than males.

Also color measurement showed differences on chicken sex but only for the *b** parameter of the CIELab Detection System. In the CIELab System the parameters *L* indicate color from black to white (0-100), *a** from green to red (-a +a) and *b** values indicate color tone from blue to yellow (-b +b). *b** parameter showed significant differences in female breasts, higher than male probably due to morphological sex traits.

Tab. 1. Mean values (*n* = 3) of color measurements. Values followed by the same letters in the same column do not differ according to test post hoc (Tukey's HSD) (* p < 0.001).**

Breast Type	Sample Code	L	a*	b*
	29	83.2	1.1	17.1 a
CF	**40**	78.7	2.8	19.2 a
	48	72.8	3.5	18.0 a
	34	81.6	2.4	15.4 b
CM	**39**	82.1	1.7	16.4 b
	47	80.6	2.4	14.9 b
	35	81.7	1.2	17.4 a
LF	**22**	79.4	2.3	15.4 a
	46	81.2	1.5	16.8 a
	36	81.2	2.1	15.8 b

LM	**37**	82.3	2.1	14.0 b
	8	80.5	2.9	14.8 b

Tab. 2. Weights of 12 raw and cooked breast samples. Values (*n* = 3) followed by the same letters in the same column do not differ according to test post hoc (Tukey's HSD) (* p < 0.001). Mean values of cooking loss are expressed as a percentage of weight lost after cooking.**

Breasts Type	Sample Code	Raw Weight	Cooked Weight	Δ Weight	Cooking Loss %	Cooking Loss % (mean)
CF	**29**	161.2 b	122.3 b	38.9	24.1	
CF	**40**	148.1 b	107.7 b	40.4	27.3	26.0 n.s.
CF	**48**	166.4 b	122.3 b	44.1	26.5	
CM	**34**	200.1 a	159.3 a	40.8	20.4	
CM	**39**	214.4 a	171.3 a	43.1	20.1	21.0 n.s.
CM	**47**	231.4 a	179.6 a	51.8	22.4	
LF	**35**	166.5 b	124.0 b	42.5	25.5	
LF	**22**	180.0 b	139.4 b	40.6	22.6	23.6 n.s.
LF	**46**	172.6 b	133.2 b	39.4	22.8	
LM	**36**	201.0 a	159.5 a	41.5	20.6	
LM	**37**	221.3 a	178.0 a	43.3	19.6	19.6 n.s.
LM	**8**	204.7 a	166.7 a	38.0	18.6	

Second trial results

Results from color measurement showed differences only for the *b** parameter of the CIELab Detection System (**Tab.3**). In the CIELab System, the *L* parameter indicates the lightness and ranges from 0 (no lightness) to 100 (maximum lightness), which conventionally are indicated from black to white; *a** represents color gradations from green to red (*-a*, +a**) and *b** parameter indicate color gradations from blue to yellow (*-b*, +b**). In particular, the *b** values showed strong significant differences between dietary treatments for both slaughtered ages. In particular, the commercial feed sample (MC) results less yellow with respect to sustainable feed and live larvae based feed.

Tab. 3. Mean values (*n* = 18) of color measurements. Values followed by the same letters in the same column do not differ according to test post hoc (Tukey's HSD) (*** p < 0.001).

Slaughter age	Breast Type	L	a*	b*
150 days	LV	76.0	3.1	16.1 a
	MC	77.0	3.4	13.7 b
180 days	LV	79.8	2.3	15.4 a
	MC	79.3	2.8	12.8 b

Concerning the cooking loss, that is weight loss after boiling chicken breasts, the samples showed no significant differences (**Tab.4**).

Tab. 4. Mean values (*n* = 6) of raw and boiled weights. No statistical significance was found between dietary treatments. Mean values of cooking loss are expressed as a percentage of weight lost after boiling.

Slaughtered ages	Breasts Type	Raw weight	Cooked weight	Δ weight	Cooking loss%
150 DAYS	Control	56.0	41.3	14.7	26.3
	LL	59.8	42.7	17.2	28.2
180 DAYS	Control	47.0	38.7	8.3	18.3
	LL	50.3	41.3	9.0	17.6

2.3 Sensory evaluation

First trial:

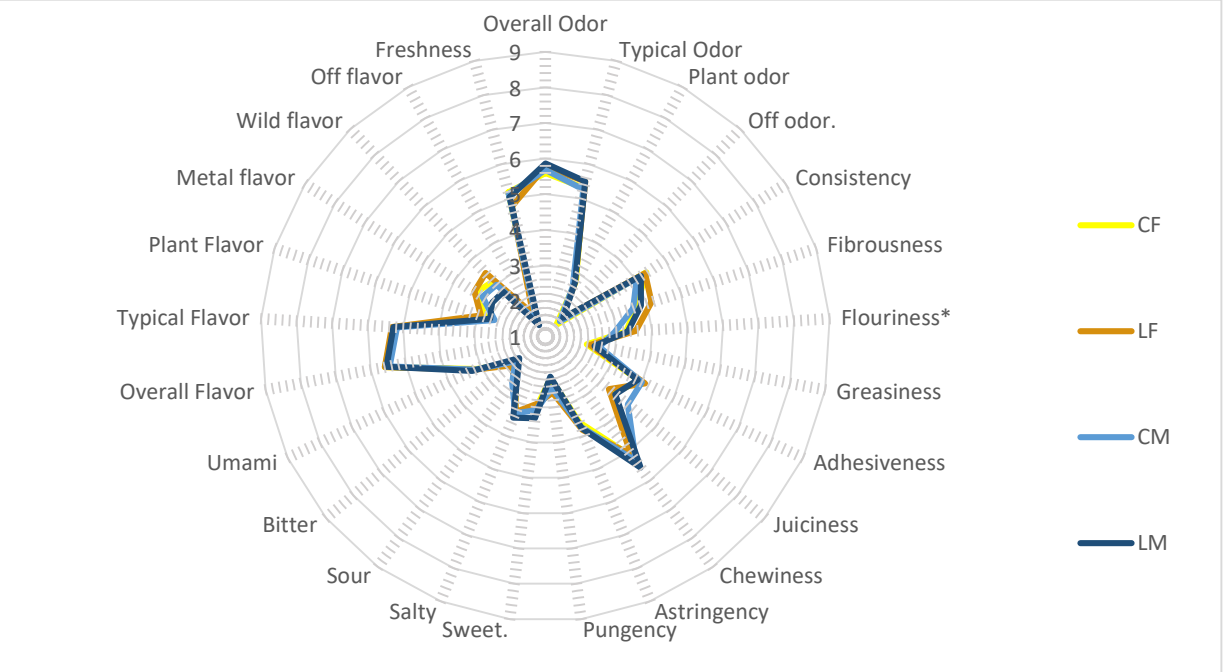
Values are means of panel judgments (2 replicates x product). Data have been submitted to statistical analysis by ANOVA and post hoc test (Tukey's HSD). Sensory evaluation (**Tab. 5 and fig.5**) showed similar results for each breast samples. Significant differences were not found.

Tab 5. List of attributes evaluated in Descriptive analysis (DA) with corresponding mean values of intensity (*n* = 6). Test performed in duplicate by 11 trained judges using a 9-point scale.

Breast Type	CF	LF	CM	LM
Overall Odor	5.6	5.8	5.7	5.9
Typical Odor	5.3	5.5	5.3	5.5
Plant Odor	2.8	2.7	2.6	2.7
Off Odor	1.5	1.7	1.6	1.7
Consistency	4.4	4.3	4.0	4.2
Fibrousness	3.7	4.1	3.6	3.8
Flouriness	3.3	3.5	3.0	3.3
Greasiness	2.2	2.3	2.5	2.4

Adhesiveness	4.0	4.1	4.0	3.9
Juiciness	3.5	3.3	4.0	3.5
Chewiness	5.2	5.1	5.3	5.5
Astringency	3.6	3.8	3.7	3.8
Pungency	2.2	2.6	2.5	2.1
Sweet	3.0	2.9	3.1	3.3
Salty	3.3	3.3	3.3	3.5
Sour	2.4	2.5	2.6	2.3
Bitter	2.1	2.3	2.1	2.0
Umami	3.1	3.2	3.2	3.3
Overall Flavor	5.6	5.6	5.5	5.5
Typical Flavor	5.3	5.3	5.2	5.3
Plant Flavor	2.8	2.9	2.5	2.6
Metal Flavor	3.3	3.4	3.1	2.8
Wild Flavor	3.1	3.5	3.0	2.7
Off Flavor	1.6	1.7	1.5	1.4
Freshness	5.2	4.8	5.1	5.0

Fig. 5. Sensory profiles of breasts. Mean values (test performed in duplicate by 11 trained judges using a 9-point scale) were reported.



Second trial

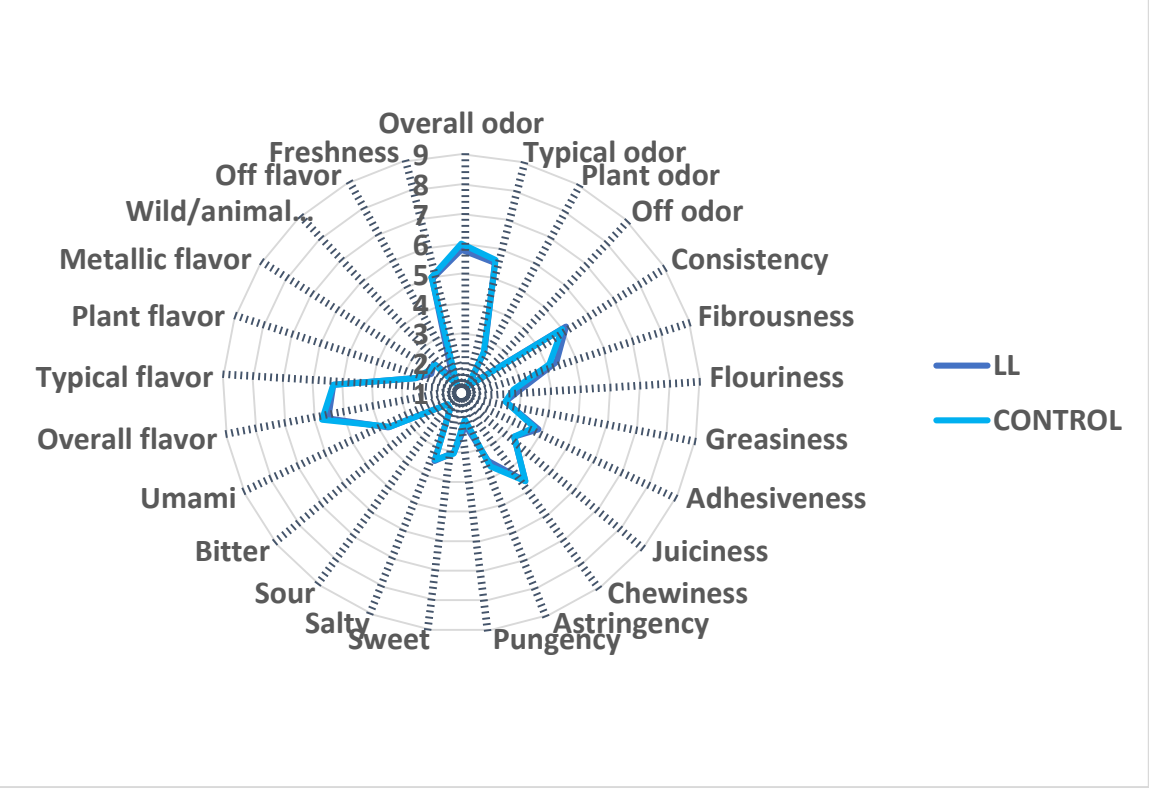
Values are means of panel judgments (2 replicates x product). Data have been submitted to statistical analysis by ANOVA and post hoc test (Tukey's HSD). The comparison of the 3 products (Tab.6) shows differences in texture, the LV samples show higher value for Consistency, no significant differences emerged for the other attributes and the samples are very similar.

Tab. 6. Descriptive Analysis (DA) of products at 150 days of life, live larvae (LL) and control (Control)

	LL 150 days	Control 150 days
Overall odor	**5.8**	**6.0**
Typical odor	**5.5**	**5.6**
Plant odor	**2.6**	**2.6**
Off odor	**1.4**	**1.3**
Consistency	**5.2**	**5.0**
Fibrousness	**4.4**	**4.1**
Flouriness	**3.0**	**2.8**
Greasiness	**2.5**	**2.5**
Adhesiveness	**3.9**	**3.7**

Juiciness	**3.3**	**3.3**
Chewiness	**4.7**	**4.7**
Astringency	**3.5**	**3.7**
Pungency	**2.1**	**1.9**
Sweet	**3.0**	**3.1**
Salty	**3.5**	**3.4**
Sour	**1.7**	**1.7**
Bitter	**1.6**	**1.6**
Umami	**3.7**	**3.7**
Overall flavor	**5.6**	**5.8**
Typical flavor	**5.3**	**5.3**
Plant flavor	**2.6**	**2.6**
Metallic flavor	**2.2**	**2.4**
Wild/animal flavor	**2.4**	**2.3**
Off flavor	**1.6**	**1.3**
Freshness	**5.0**	**5.0**

Fig. 6. Sensory profiles from Descriptive Analysis of chickens breasts slaughtered at 150 days.



Values are means of panel judgements (2 replicates x product). The comparison of the products (Tab.7) at 180 days, shows differences related to Texture. In particular LV shows the most intense values for Consistency, Fibrousness and the lower intensity for the Chewiness.

Tab.7. Descriptive Analysis (DA) of products at 180 days of life, live larvae (LL) and control feed (Control).

	LL 180 days	Control 180 days
Overall odor	5.3	5.4
Typical odor	5.1	5.4
Plant odor	2.2	2.3
Off odor	1.5	1.4
Consistency	4.9	4.5
Fibrousness	4.4	4.0
Flouriness	2.9	2.7
Greasiness	2.7	2.7
Adhesiveness	3.4	3.5
Juiciness	3.1	3.4
Chewiness	4.3	4.8
Astringency	3.2	3.5
Pungency	1.6	1.6
Sweet	2.8	2.4
Salty	3.6	3.9
Sour	1.9	1.9
Bitter	1.8	1.6
Umami	4.0	4.1
Overall flavor	5.3	5.4
Typical flavor	5.2	5.3
Plant flavor	2.1	2.4
Metallic flavor	2.5	2.6
Wild/animal flavor	2.2	2.1
Off flavor	1.3	1.3
Freshness	4.9	4.9

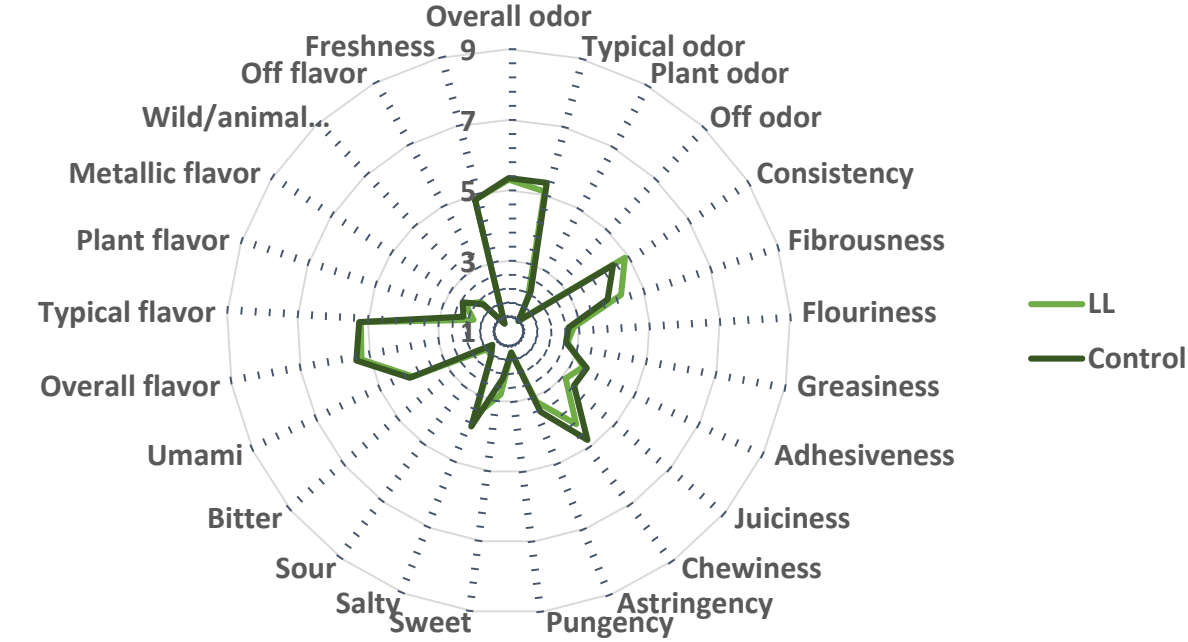


Fig. 7. Sensory profiles from Descriptive Analysis of chickens breasts slaughtered at 180 days.

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