

Physicochemical Integrity and Sensory Profiling of Algerian Honeys: Insights into Floral Diversity and Consumer Perception [†]

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[†] Presented at the 29th International Electronic Conference on Synthetic Organic Chemistry (ECSOC-29); Available online: <https://sciforum.net/event/ecsoc-29>.

Abstract

Thirty-seven honeys from western Algeria of diverse floral origins were compared with Polish references. All complied with European quality criteria (moisture 14.7–20.9%, acidity 8.0–40.3 meq/kg, HMF 1.8–49.4 mg/kg, proline 266–1201 mg/kg). Sensory evaluation showed significantly higher Polish scores for taste ($+1.22 \pm 0.42$ vs. $+0.18 \pm 0.52$; $p = 0.009$) and aroma ($+0.72 \pm 0.43$ vs. -0.26 ± 0.36 ; $p = 0.016$). Multivariate analysis (65% variance) identified three clusters, with Algerian rosemary and multiflorals achieving consumer acceptance similar to Polish products, highlighting their competitiveness in specialised markets.

Keywords: Algerian honey; physicochemical parameters; sensory analysis

Academic Editor(s): Name

Published: date

Citation: Bereksi-Reguig, D.; Allali, H.; Tani, N.K.; Kowalska, G.; Kowalczyk, D.; Wyrostek, J.; Zielinska, E.; Kowalski, R. Physicochemical Integrity and Sensory Profiling of Algerian Honeys: Insights into Floral Diversity and Consumer Perception. *Chem. Proc.* **2025**, volume number, x. <https://doi.org/10.3390/xxxxx>

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1. Introduction

Honey is a natural matrix rich in sugars, amino acids, enzymes, minerals, phenolic compounds, and volatiles that collectively determine its nutritional and functional properties [1]. It is consumed as an additive-free sweetener with long stability, while beekeeping provides significant socioeconomic benefits, particularly through pollination and rural development [2,3]. Bees and their products are also increasingly employed as bioindicators of environmental quality [4].

The composition and characteristics of honey vary according to botanical and geographical origin, which influence physicochemical attributes such as moisture, acidity, and colour, and thereby affect sensory properties [5,6]. Honeys are classified as monofloral when dominated by a single floral source or multifloral when derived from diverse plant species [7]. Rising consumer interest in authenticity has stimulated the

characterisation of both categories using melissopalynology, complemented by physico-chemical and sensory analyses, while volatile profiling offers additional discriminatory capacity [8].

In Algeria, reliable data on honey production remain scarce. Estimates indicate nearly 1.2 million colonies and about 20,000 beekeepers, though average yields remain below 4 kg per hive [3]. Western Algeria, with its Mediterranean–Saharan climate and rich floral diversity, provides favourable conditions for honeys with distinctive physicochemical and sensory profiles. By contrast, Poland represents a mature European market with established standards, making comparative analyses particularly relevant. Importantly, consumer perception and willingness to pay are strongly influenced by declared geographical origin, often more than by intrinsic taste [9].

This study evaluated 37 western Algerian honeys of diverse floral origins by determining their physicochemical properties and sensory characteristics, with Polish honeys serving as references for quality comparison and international positioning.

2. Materials and Methods

2.1. Samples and Reagents

Analytical-grade reagents were employed, including hydroxymethylfurfural (HMF) and proline (Sigma-Aldrich®, Germany). Thirty-seven Algerian honeys (codes S1–S37) were collected between March 2017 and August 2018 from beekeepers across eight western regions (Figure 1). The botanical origins covered monofloral types—lavender, rosemary, thyme, sweet white mustard, milk thistle, carob, orange, euphorbia, eucalyptus, camphor, jujube, sage, harmal—and multifloral blends. Detailed information on provenance and floral sources is presented in Table 1. Samples were stored in amber glass at 4 °C until analysis. Four Polish honeys (C38–C41: multifloral, heather, buckwheat) were included as sensory references with certified provenance.

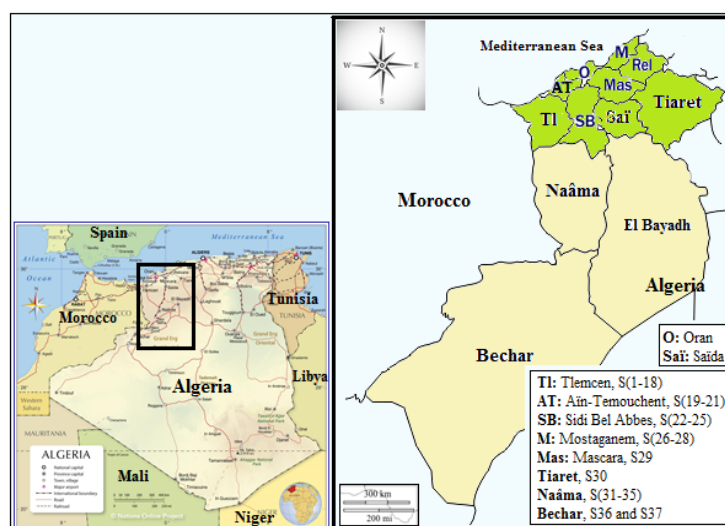


Figure 1. Map of western Algeria with sampling locations.

Table 1. Origin and floral source of honey samples from western Algeria.

Region	Sample	Flower Type	Scientific Name	Harvest Season/Year
Tlemcen	S1	Lavender	<i>Lavandula vera</i> D.C.	Summer 2018
	S2	Rosemary	<i>Rosmarinus officinalis</i> L.	Spring 2018
	S3	Multifloral	Multifloral	Spring 2018
	S4	Multifloral	Multifloral	Summer 2017
	S5	Multifloral	Multifloral	Summer 2017

	S6	Sweet white mustard	<i>Sinapis alba</i> L.	Summer 2017
	S7	Thyme	<i>Thymus vulgaris</i> L.	Spring 2018
	S8	Milk thistle	<i>Silybum marianum</i> (L.) Gaertn.	Summer 2018
	S9	Multifloral	Multifloral	Autumn 2017
	S10	Carob	<i>Ceratonia siliqua</i> L.	Autumn 2017
	S11	Thyme	<i>Thymus vulgaris</i> L.	Spring 2017
	S12	Carob	<i>Ceratonia siliqua</i> L.	Spring 2017
	S13	Multifloral	Multifloral	Summer 2018
	S14	Multifloral	Multifloral	Spring 2017
	S15	Multifloral	Multifloral	Summer 2017
	S16	Orange	<i>Citrus sinensis</i> L.	Spring 2017
	S17	Multifloral	Multifloral	Spring 2018
	S18	Milk thistle	<i>Silybum marianum</i> (L.) Gaertn.	Summer 2018
	S19	Multifloral	Multifloral	Spring 2018
Ain-Temouchent	S20	Multifloral	Multifloral	Summer 2018
	S21	Multifloral	Multifloral	Spring 2018
	S22	Euphorbia	<i>Euphorbia</i> L.	Spring 2017
Sidi Bel Abbes	S23	Milk thistle	<i>Silybum marianum</i> (L.) Gaertn.	Spring 2017
	S24	Multifloral	Multifloral	Spring 2017
	S25	Eucalyptus	<i>Eucalyptus globulus</i> Labill.	Spring 2017
	S26	Camphor	<i>Cinnamomum camphora</i> L.	Autumn 2017
Mostaganem	S27	Eucalyptus	<i>Eucalyptus globulus</i> Labill.	Summer 2017
	S28	Orange	<i>Citrus sinensis</i> L.	Spring 2017
Mascara	S29	Rosemary	<i>Rosmarinus officinalis</i> L.	Spring 2017
Tiaret	S30	Multifloral	Multifloral	Spring 2018
	S31	Multifloral	Multifloral	Spring 2017
	S32	Jujube	<i>Ziziphus lotus</i> L.	Spring 2017
Naâma	S33	Jujube	<i>Ziziphus lotus</i> L.	Spring 2017
	S34	Sage	<i>Salvia officinalis</i> L.	Spring 2017
	S35	Harmal	<i>Peganum harmala</i> L.	Spring 2017
Bechar	S36	Multifloral	Multifloral	Winter 2017
	S37	Sweet white mustard	<i>Sinapis alba</i> L.	Spring 2017

2.2. Physicochemical Analyses

Standard procedures [10,11] were applied. Moisture was determined refractometrically, while pH and free acidity were measured by potentiometry and titration with 0.1 M NaOH. Electrical conductivity was obtained from 20% (*w/v*) honey solutions at 20 °C. Hydroxymethylfurfural was quantified spectrophotometrically at 284 nm against sodium bisulfite blanks. Specific optical rotation was recorded with a polarimeter. Proline was determined spectrophotometrically following reaction with ninhydrin. Colour attributes were measured instrumentally in the CIELAB system (L^* , a^* , b^* , C_{ab}^* , and h_{ab}°). Sugar composition (fructose, glucose, sucrose, maltose) was established by HPLC with refractive index detection. All analyses were performed in triplicate.

2.3. Sensory Evaluation

Sensory assessment was conducted at the University of Life Sciences, Lublin, by nine trained panellists (ISO 8586 certified). Each sample (30 g) was presented at 20 ± 2 °C in coded transparent jars. Assessors scored taste, aroma, and colour using a five-point hedonic scale (+2 = “like very much”, −2 = “dislike very much”) and completed an 11-term Check-All-That-Apply (CATA) questionnaire covering odour and taste descriptors. Each sample was evaluated in three sessions under controlled conditions, with palate cleansing

provided. Ethical approval was granted by the local ethics committee (Approval No. UKE/54/2025), and all participants gave written informed consent.

2.4. Statistical Analysis

All data were expressed as mean $\pm$ standard deviation. One-way ANOVA with Duncan's test ($\alpha = 0.05$) evaluated physicochemical differences. Hedonic scores were compared between Algerian and Polish honeys by independent t-tests. CATA data were analysed by Cochran's Q test, followed by McNemar's test with Bonferroni correction. Principal Component Analysis (PCA) summarised sensory variation, while Hierarchical Cluster Analysis (HCA) explored groupings based on PCA scores. Statistical analyses were performed using SPSS v.22. Representative literature values for Polish honeys are provided in Table 3.

3. Results and Discussion

3.1. Physicochemical Parameters of Algerian Honeys

Thirty-seven honey samples from western Algeria (S1–S37) exhibited moisture contents between $14.67 \pm 0.11\%$ (sage, S34) and $20.87 \pm 0.61\%$ (thyme, S7) (Table 2). All values were within Codex Alimentarius thresholds, indicating good stability. Regional patterns emerged: honeys from drier zones averaged 16.47%, compared with 18.00% in more humid regions, confirming climatic influence [12]. Comparable values have been reported for Moroccan (17.8–20.0%) [13] and Tunisian honeys (17.27–19.12%) [14].

The pH values ranged from 3.47 ± 0.15 (rosemary, S2) to 5.60 ± 0.04 (multifloral, S5), consistent with ranges in Algerian (3.75–5.56) [15] and neighbouring honeys. Free acidity spanned 8.00 ± 1.00 meq/kg (multifloral, S12) to 40.33 ± 2.52 meq/kg (rosemary, S29), all below the Codex limit of 50 meq/kg [16]. Variability reflected floral source and harvest season [17].

Electrical conductivity varied from 0.16 ± 0.01 mS/cm (multifloral, S3) to 1.18 ± 0.02 mS/cm (multifloral, S20). Most honeys were nectar type ($EC \leq 0.8$ mS/cm), except three multiflorals exceeding this value, a trait linked to mineral richness. These results align with Algerian (0.29–1.35 mS/cm) [18] and Tunisian ranges (0.39–0.89 mS/cm) [14].

HMF values remained low (mean ≈ 15 mg/kg), with maxima at 47.43 ± 2.22 mg/kg (multifloral, S5), reflecting freshness. Similar ranges were reported in Moroccan and Spanish honeys [19,20]. Proline, a marker of maturity, ranged from 265.95 ± 1.28 mg/kg (S5) to 987.08 ± 2.61 mg/kg (sweet white mustard, S6), exceeding the minimum threshold (180 mg/kg) for authentic honeys [16].

Table 2. Physicochemical and colourimetric properties of honey samples from western Algeria.

Sample	Physical and Chemical Parameters										Sugar Content				Colour Data				
	Moisture Content *	pH *	Free Acidity *	EC *	HMF *	Proline *	$[\alpha]_D^{20}$ *	G *	F *	(M + S) *	(F + G) *	F/G *	G/W *	Total Sugar Content * (%)	L*	a*	b*	C _{ab} *	h _{ab} °
	(%)		(meq/kg)	(mS/cm)	(mg/kg)	(mg/kg)		(%)	(%)	(%)	(%)								
S1	17.33	3.61	9.67	0.45	11.27	293.31	(-) 12.50	31.48	38.94	5.94	70.42	1.23	1.83	76.37	37.61	2.87	5.31	6.04	61.63
S2	17.13	3.47	12.50	0.26	32.26	431.32	(-) 10.89	30.65	40.36	7.11	71.01	1.31	1.79	78.13	42.80	2.81	4.98	5.72	60.59
S3	18.27	3.89	14.00	0.21	6.30	398.73	(-) 9.55	32.40	40.76	6.67	73.16	1.25	1.78	79.84	40.50	6.79	5.93	9.01	41.15
S4	17.43	4.85	28.33	0.27	25.70	587.93	(-) 9.92	22.07	43.53	7.75	65.60	1.97	1.27	73.35	40.50	6.79	5.93	9.01	41.15
S5	15.46	5.60	13.00	0.25	47.43	265.95	(-) 8.85	34.64	34.12	6.39	68.76	0.98	2.25	75.15	42.74	2.17	7.17	7.49	73.01
S6	18.60	4.00	18.67	0.55	33.93	987.08	(-) 14.08	32.13	36.22	2.24	68.34	1.12	1.73	70.59	42.63	2.23	11.34	11.55	78.85
S7	20.87	4.29	17.33	0.29	9.73	421.04	(-) 10.39	30.01	37.24	8.14	67.26	1.24	1.42	75.40	57.30	1.91	4.81	5.17	68.33
S8	17.07	4.29	11.00	0.47	7.63	725.14	(-) 11.32	31.98	41.50	3.76	73.49	1.29	1.87	77.24	53.69	1.90	3.51	4.01	61.36
S9	16.80	4.66	22.67	0.25	3.82	655.21	(-) 11.17	34.33	37.88	5.21	72.21	1.10	2.07	77.43	37.91	2.89	4.96	5.74	59.79
S10	18.40	4.39	15.83	0.42	26.55	800.42	(-) 8.87	31.10	41.65	5.33	72.76	1.33	1.69	78.09	34.18	-0.57	-0.57	0.81	225.09
S11	15.93	4.62	30.33	0.44	19.76	924.54	(-) 11.02	33.99	40.31	4.54	74.30	1.18	2.11	78.84	41.51	1.84	4.49	4.85	67.85
S12	18.73	4.37	8.00	0.72	40.62	684.42	(-) 11.40	34.32	35.87	4.11	70.20	1.04	1.85	74.31	45.06	1.13	5.81	5.92	78.93
S13	15.13	4.11	20.00	0.91	17.81	734.81	(-) 10.37	33.07	39.08	3.91	72.15	1.18	2.19	76.06	60.02	1.99	7.94	8.22	75.65
S14	18.07	4.61	11.00	0.51	6.02	359.58	(-) 10.59	30.25	41.23	3.87	71.49	1.36	1.66	75.36	41.14	0.85	0.78	1.18	43.16
S15	16.13	4.29	21.3	0.38	8.42	478.75	(-) 9.17	28.31	39.91	5.66	68.22	1.41	1.78	73.88	38.55	10.21	7.29	12.55	35.50
S16	18.00	4.27	15.00	0.16	49.43	412.83	(-) 8.75	28.26	39.85	5.60	68.11	1.41	1.57	73.71	38.60	10.24	7.30	12.5	35.45
S17	20.06	4.63	19.33	0.42	4.64	871.39	(-) 11.66	35.27	38.77	4.22	74.04	1.09	1.71	78.26	54.43	2.84	6.33	6.94	65.87
S18	16.67	3.81	15.67	0.32	35.63	905.82	(-) 10.69	34.67	39.93	4.19	74.61	1.15	2.08	78.80	50.86	3.02	13.25	13.59	77.17
S19	19.87	5.10	39.33	1.18	7.91	301.81	(-) 10.48	30.81	37.53	6.23	68.35	1.22	1.53	74.58	42.81	2.97	7.77	8.31	69.10
S20	16.33	4.38	10.33	1.04	2.45	1006.34	(-) 10.92	37.17	40.78	3.53	77.94	1.09	2.29	81.47	45.34	2.37	9.34	9.64	75.73
S21	18.06	4.19	11.83	0.50	9.48	899.21	(-) 9.86	31.92	37.34	4.93	69.27	1.17	1.75	74.20	49.45	2.32	5.86	6.30	68.31
S22	14.87	4.36	15.67	0.24	4.44	458.30	(-) 9.51	36.99	35.85	5.33	72.84	0.97	2.52	78.18	48.45	1.34	2.32	2.68	60.04
S23	16.66	4.52	20.33	0.44	7.54	1132.73	(-) 10.72	28.84	39.15	5.11	67.99	1.35	1.73	73.10	41.79	8.36	7.56	11.27	42.24
S24	17.60	3.96	20.67	0.16	19.31	794.23	(-) 9.70	27.87	38.67	4.64	66.53	1.38	1.58	71.17	44.41	1.10	5.40	5.52	78.41
S25	17.13	4.10	20.33	0.32	18.11	1078.64	(-) 10.46	27.87	38.67	4.64	66.53	1.38	1.63	71.17	37.6	1.86	5.56	5.87	71.51
S26	18.07	4.72	25.00	0.32	4.66	491.47	(-) 9.46	30.03	43.13	6.08	73.16	1.43	1.66	79.24	45.97	2.07	3.11	3.74	56.39
S27	16.13	4.29	33.67	0.58	10.47	741.25	(-) 11.35	30.53	37.45	4.09	67.98	1.22	1.90	72.08	35.12	2.35	3.06	3.86	52.71
S28	17.47	4.65	28.00	0.21	16.77	285.59	(-) 10.13	31.16	37.91	7.02	69.07	1.21	1.79	76.09	41.65	2.10	4.53	4.99	65.10
S29	16.80	4.21	40.33	0.25	34.90	1200.66	(-) 10.56	31.45	41.27	5.90	72.72	1.31	1.87	78.62	35.19	2.09	3.48	4.06	59.05
S30	15.87	4.01	9.33	0.36	1.79	1117.33	(-) 8.30	35.60	40.13	5.12	75.73	1.13	2.27	80.85	40.14	2.01	6.86	7.15	73.68

S31	16.33	3.94	17.16	0.44	4.34	326.50	(-) 9.57	27.16	47.47	6.24	74.63	1.75	1.68	80.87	37.77	7.39	7.80	10.74	46.52
S32	15.80	4.69	17.16	0.25	28.29	478.67	(-) 10.40	33.04	39.78	5.88	72.82	1.20	2.07	78.70	48.36	2.30	7.28	7.64	72.40
S33	15.27	5.31	12.33	0.22	15.25	637.61	(-) 10.10	30.96	37.53	6.62	68.50	1.21	2.01	75.12	43.10	2.74	8.90	9.32	72.88
S34	14.67	4.53	22.67	0.20	36.53	508.88	(-) 10.96	34.50	36.38	5.97	70.89	1.05	2.35	76.86	49.77	3.21	13.84	14.21	76.98
S35	16.60	4.99	15.83	0.24	45.36	394.83	(-) 10.98	27.83	33.88	6.41	61.71	1.21	1.67	68.12	57.84	1.67	13.06	13.17	82.73
S36	18.20	5.01	9.00	0.46	4.54	279.72	(-) 10.59	30.53	35.39	8.22	65.92	1.16	1.71	74.14	43.60	2.41	13.90	14.11	80.18
S37	16.93	4.48	13.83	0.25	40.64	845.61	(-) 10.22	38.01	34.45	3.82	72.47	0.90	2.24	76.29	46.23	1.73	3.37	3.79	62.89

EC: Electrical conductivity; HMF: Hydroxymethyl furfural; $[\alpha]_D^{20}$: Specific optical rotation; G: Glucose; F: Fructose; M: Maltose; S: Sucrose; W: Water; L*: clarity (L* = 0, black and L* = 100, colorless); a*: green/red color component (a* > 0, red and a* < 0, green); b*: blue/yellow color component (b* > 0, yellow and b* < 0, blue); C_{ab}^* : chroma and h_{ab}° : hue angle. *: The results indicate statistical significance at $p < 0.05$.

3.2. Compositional Patterns Linked to Floral Attributions

Sugar profiles confirmed authenticity. Total sugar content ranged from $68.12 \pm 0.55\%$ (harmal, S35) to $81.47 \pm 0.05\%$ (multifloral, S20) (Table 2). Fructose predominated over glucose in most samples, except euphorbia (S22) and sweet white mustard (S37), where glucose was higher—a feature also seen in rapeseed and dandelion honeys [21].

Fructose concentrations varied from $33.88 \pm 0.34\%$ (harmal, S35) to $47.47 \pm 1.21\%$ (multifloral, S31), while glucose ranged between $22.07 \pm 0.17\%$ (multifloral, S4) and $38.01 \pm 0.90\%$ (sweet white mustard, S37). Sucrose and maltose contents were consistently low (2.24–8.22%), excluding adulteration [22].

Crystallisation potential was inferred from fructose/glucose (F/G) and glucose/water (G/W) ratios. The F/G ratio ranged from 0.90 ± 0.02 (S37) to 1.97 ± 0.02 (S4), while G/W exceeded 2.0 in one-third of samples, supporting stability. Such ratios align with European honeys [23,24].

Optical rotation was consistently negative, spanning $-14.08 \pm 0.04^\circ$ (S6) to $-8.30 \pm 0.14^\circ$ (S30) (Table 2). Negative levorotation, typical of nectar honeys, confirmed authenticity. Values agreed with Algerian (-14.35° to -4.65°) [25], Portuguese (-15.4° to -11.9°) [19], and Spanish honeys (-8.94° to -14.13°) [26].

3.3. Indicators of Freshness and Quality

Low HMF concentrations combined with elevated proline levels underscored honey maturity and absence of overheating. Proline exceeded 500 mg/kg in rosemary (S29: 1200.66 ± 1.92 mg/kg) and milk thistle honeys (S23: 1132.73 ± 2.49 mg/kg), highlighting nectar–pollen interactions. Such values surpass Algerian reports (551–852 mg/kg) [27] and compare with Moroccan ranges (442–1207 mg/kg) [28].

The acidity–pH relationship confirmed stability. For instance, rosemary honey (S29) combined high free acidity (40.33 meq/kg) with low pH (3.47), supporting its preservation potential. None of the samples exceeded Codex thresholds, strengthening evidence of freshness and good handling practices.

3.4. Colour and Sensory Characterisation

CIELAB measurements revealed marked diversity (Table 2). Lightness (L^*) ranged from 34.18 ± 0.20 (carob, S10) to 60.02 ± 2.47 (multifloral, S13). Red–green coordinate (a^*) values were highest in orange blossom (10.24 ± 0.05 , S16) and lowest in carob (-0.57 ± 0.07 , S10). The yellow–blue axis (b^*) extended from 0.78 ± 0.18 (multifloral, S14) to 13.90 ± 0.38 (multifloral, S36).

Chroma varied from 0.81 ± 0.06 (carob, S10) to 14.21 ± 2.75 (sage, S34), while hue angle values distinguished light floral honeys (e.g., orange blossom, S16) from darker ones (e.g., eucalyptus, S27). Most Algerian samples clustered in dark or dark amber classes, consistent with high pigment and mineral contents typical of semiarid ecosystems [29,30].

Sensory evaluation confirmed broad variability. Hedonic scores reflected preferences for orange, thyme, and multifloral honeys, while some dark honeys (carob, eucalyptus) were perceived as bitter or less sweet. Check-All-That-Apply (CATA) responses highlighted descriptors such as “herbal” and “characteristic flavour” in rosemary and eucalyptus honeys. Principal Component Analysis differentiated samples according to floral attributions, while cluster analysis grouped dark, mineral-rich honeys separately from lighter, sweeter varieties.

3.5. Comparative Assessment with Polish Honeys

Comparisons with Polish references (Table 3) revealed broad physicochemical overlap. Moisture (14.7–20.9%) was comparable to Polish multiflorals (16.9–20.0%). pH (3.5–

5.6) and EC (0.16–1.18 mS/cm) were within Polish nectar ranges (0.30–0.64 mS/cm). Free acidity (8–40 meq/kg) matched Polish multifloral and heather honeys but remained lower than buckwheat (~55 meq/kg).

Table 3. Reported Physicochemical Characteristics of Polish Honeys [31–43].

Physical and chemical parameters							
Honey type	Moisture content * (%)	pH *	Free acidity * (meq/kg)	EC * (mS/cm)	HMF * (mg/kg)	Proline * (mg/kg)	$[\alpha]_D^{20}$ *
multifloral	17.0	3.87	30.3	0.41	6.91–8.42	585	(−11.0)–(−2.2)
	16.9	4.1 ± 0.2	30	0.40	0.5–13.9	312.1–443.1	
	18.6		11.9–28.7	0.303–0.584			
	18.0–20.0		34.04 ± 25.33				
	15.7–19.0						
heather	18.3	4.07–4.66	35.7	0.64	0.7–14.8	861	(−14.35)–(−15.03)
	18.6–19.9	4.25 ± 0.01	14.9–33.8	0.533–0.583		33.1–92.1	
	15.4–21.9	3.65	32.33 ± 1.03	0.37–0.82			
buckwheat	19.9	3.44–3.80	54.7	0.43	6.4–16.0	892	(−12.7)–(−5.3)
	18.5	4.07 ± 0.16	45.5	0.51	3–79		(−12.0)–(−7.5)
	16.5		37.8–50.8	0.326–0.507			
	18.1–19.9		34.25 ± 10.67				
	16.5–20.8						
	16.2–20.8						
Sugar content.							
	G * (%)	F * (%)	(M + S) * (%)	(F + G) * (%)	F/G *	Total sugar content * (%)	
multifloral	30.22–35.42	33.72–37.70	3.50–7.99	63.94–71.96	1.03–1.13	79.5–82.8	
	34.07–37.74	41.99–45.24	1.12–1.27	56.0–84.1	1.11–1.32		
	19.0–36.3	37.0–52.0					
heather	30.27–33.55	37.12–40.92	4.10–8.42	67.39–73.94	1.20–1.27	71.49–82.36	
	25.9–34.3	36.5–43.3	1.3–3.3	62.4–76.1	1.12–1.46	72.0–72.9	
buckwheat	24.0–31.1	39.3–53.8		63.4–80.1		77.8–82.0	
						77.6–82.1	
Colour data							
	L*	a*	b*	C _{ab} [*]	h _{ab} [°]		
multifloral	57.29	5.12	34.90	22.74 ± 9	0.05 ± 0.04		
	40.51	3.50	29.94				
	56.26	6.56	37.75				
	53.7	1.7	7.2				
	42 ± 1.9	−1.14 ± 1.05	23.7 ± 8.99				
heather	26 ± 0.4	0.54 ± 0.16	5.8 ± 0.21	5.83 ± 0.2	0.09 ± 0.03		
buckwheat	3.38	1.89	3.86	9.29 ± 3.88	0.22 ± 0.35		
	8.40	8.68	9.21				
	12.29	12.78	17.7				
	39.1	1.8	−2.6				
	33 ± 8.7	2.25 ± 3.84	8.39 ± 3.48				

EC: Electrical conductivity; HMF: Hydroxymethyl furfural; $[\alpha]_D^{20}$: Specific optical rotation; G: Glucose; F: Fructose; M: Maltose; S: Sucrose; L*: clarity (L* = 0, black and L* = 100, colorless); a*: green/red color component (a* > 0, red and a* < 0, green); b*: blue/yellow color component (b* > 0, yellow and b* < 0, blue); C_{ab}^* : chroma and h_{ab}° : hue angle.

HMF levels (mean $\approx$ 15 mg/kg) were generally lower than Polish references (6.9–13.9 mg/kg [34]). Proline content (266–987 mg/kg) exceeded Polish multiflorals (312–585 mg/kg) but remained below heather and buckwheat ($\approx$ 860–890 mg/kg). All Algerian honeys were levorotatory (-14.08° to -8.30°), consistent with Polish nectar honeys (-15.0° to -2.2°) [35].

Sensory comparison indicated Algerian honeys exhibited broader aroma complexity, often with herbal or resinous notes absent in Polish samples. PCA confirmed distinct clustering between Algerian and Polish honeys, suggesting terroir-specific sensory signatures.

4. Conclusions

The integrated evaluation of western Algerian honeys confirmed compliance with international quality requirements, with moisture, acidity, proline, and sugar composition supporting authenticity and maturity. Chromatic and sensory profiles highlighted a broad spectrum, ranging from light floral types to darker samples with herbal or mild notes. Comparison with Polish references demonstrated overlapping physicochemical ranges, while several Algerian varieties, particularly rosemary and multifloral honeys, reached high hedonic acceptance and favourable descriptor frequencies. Such features strengthen their potential for premium positioning in European markets. Broader sampling across additional regions and validation through diverse consumer panels remain necessary to consolidate evidence and ensure the competitiveness of Algerian honeys in wider commercial contexts.

Author Contributions: Conceptualization, H.A. and R.K.; methodology, H.A. and R.K.; software, S.B.; validation, D.B.-R., S.B. and N.K.-T.; formal analysis, D.B.-R., J.W., E.Z. and D.K.; investigation, D.B.-R., N.K.-T., J.W., E.Z., D.K. and G.K.; resources, H.A.; data curation, D.B.-R., J.W., E.Z., D.K. and G.K.; writing—original draft preparation, H.A.; writing—review and editing, H.A. and R.K.; visualization, H.A. and R.K.; supervision, H.A. and R.K.; project administration, H.A. and R.K.; funding acquisition, G.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research was carried out within the framework of project No. B00L01UN130120220004, supported by the Ministry of Higher Education and Scientific Research of the People's Democratic Republic of Algeria in collaboration with Abou Bekr Belkaïd University, Tlemcen. Additional financial support was provided through statutory funding from the Polish Ministry of Science and Higher Education allocated to the Faculty of Food Science and Biotechnology, University of Life Sciences in Lublin. The article processing charges were covered by institutional subsidies granted by the Polish Ministry of Education and Science to the Faculties of Food Science and Biotechnology and Agrobioengineering at the same university.

Institutional Review Board Statement: The investigation complied with the ethical standards set out in the Declaration of Helsinki (revised October 2013, Fortaleza, Brazil). Ethical approval was granted by the Ethics Committee of the University of Life Sciences in Lublin under reference number UKE/54/2025.

Informed Consent Statement: All participants provided written informed consent, and the procedure was approved by the ethics committee. Recruitment took place on 1 July 2025, with sensory evaluations conducted between 1 and 3 July 2025.

Data Availability Statement: All data generated or analysed are contained within this article. Additional information is available upon request from the corresponding authors.

Acknowledgments: Grateful acknowledgement is made to the beekeepers who generously provided the honey samples.

Conflicts of Interest: The authors declare the absence of any competing interests regarding this publication.

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