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Biosecurity Gaps and Food Production Practices in Subsistence and Differentiated Backyard Poultry Systems in Central Chile

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Abstract

Backyard poultry systems (BPS) are the most widespread form of animal production worldwide, contributing to household economies and improving food availability. However, limited biosecurity measures and close human–animal interactions raise concerns regarding zoonotic disease transmission. In recent years, consumer-driven motivations have given rise to non-traditional BPS with differential attributes (BPS-DA), yet there is limited knowledge about their food production practices. This study aimed to characterize and compare practices across 25 BPS and 25 BPS-DA in the Metropolitan Region using surveys, interviews, and direct observations of egg collections and poultry slaughters. Eggs were the main animal product in both systems, with women primarily responsible for care. Poultry slaughter was reported exclusively in BPS (60%), generally performed under inadequate hygienic conditions and without veterinary oversight. These practices, (poultry slaughter and by-food production), may considerably increase the risk of human exposure to zoonotic pathogens, such as avian influenza viruses. In contrast, BPS-DA prioritized birds as companion animals (60%), free-range rearing (68%), and hobby-based production (80%). While both systems showed limited biosecurity, significant differences were found in the use of dedicated footwear ($p = 0.01$), egg collection sites ($p = 0.04$), and refrigeration ($p = 0.004$). Veterinary access was limited in both. These findings highlight critical gaps in health management and underscore the need for context-specific educational and regulatory strategies for safer backyard poultry production.

Keywords: backyard poultry production; one health; sustainability; alternative poultry farming

1. Introduction

Small-scale animal production plays a critical role in the livelihoods of millions globally. Approximately one billion people are socioeconomically dependent on livestock, and nearly 13% of the global population is closely linked to family farming systems [1,2]. In this context, backyard poultry production systems (BPS) — characterized by the rearing of domestic birds within household premises — represent the most widespread form of animal production worldwide [3–5]. These

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systems are valued for producing high-quality animal-source foods, such as eggs and meat, with minimal investment, thereby contributing to both household economies and food security [3,6]. Over 80% of the world's rural population relies on backyard poultry, which aids in poverty reduction and strengthens food access in low- and middle-income countries [3,5–7].

Despite these benefits, the close human-animal-environment interface in BPS creates favourable conditions for the maintenance and spread of infectious and zoonotic agents [8–10]. Practices such as slaughtering and handling of poultry products are documented risk factors for pathogens like *Salmonella* spp. and *Escherichia coli*, both of which pose significant public health risks [9–14]. Globally, foodborne illnesses affect approximately 600 million people and cause 420,000 deaths annually [15], a burden exacerbated by the rise of antimicrobial resistance resulting from the misuse of antimicrobial drugs in both human and veterinary contexts [16–19].

Concurrently, consumer preferences have shifted toward animal-source foods with added value attributes — such as sustainability and ethical sourcing — leading to the emergence of alternative or non-conventional backyard systems [20–23]. These systems, which we define as backyard production systems with differentiated attributes (BPS-DA), often prioritize free-range practices, animal welfare, and hobby-based motivations. Global urbanization trends have further accelerated the proliferation of such systems in residential settings, including in countries such as the U.S., Canada, the U.K., and France [24–26]. To date, no comprehensive characterization of non-traditional systems (BPS-DA) has been conducted in Chile.

In Latin America, emerging evidence highlights the sanitary and hygienic shortcomings of backyard poultry systems, particularly regarding food production practices [27–29]. In Chile, backyard poultry systems are widely distributed, especially in peri-urban and rural settings, but often operate informally and with limited veterinary oversight [30–32]. National studies have revealed a 4.6% prevalence of *Salmonella* spp. at the flock level [33], and a 7.7% prevalence of Shiga toxin-producing *E. coli* (STEC) in backyard poultry [34]. Antimicrobial residues have also been detected in eggs from these systems, indicating the use of veterinary drugs without professional guidance [32,35]. More recently, [36] reported a 43.5% seroprevalence and a 10.1% molecular prevalence of zoonotic influenza viruses in backyard birds from Central Chile, highlighting their role as a reservoir of pathogens of public health concern.

While several studies acknowledge the public health relevance of BPS, poultry slaughter practices remain a critical but largely understudied stage of food production in backyard systems — despite being a high-risk point for zoonotic pathogen exposure [9,10].This is particularly concerning given that animal slaughter outside of authorized facilities is legally prohibited. Yet, there is evidence suggesting that sick birds from backyard systems are routinely slaughtered, consumed, exchanged, or sold without awareness of the associated health risks [31,32]. Additionally, eggs from these systems are not currently included in Chile's official national surveillance programs for antimicrobial residues [37], underscoring critical vulnerabilities in informal, unregulated food channels.

Given these regulatory gaps, biosecurity shortcomings, and emerging public health risks, there is a critical need to understand how different types of backyard poultry systems operate in practice. This study aims to characterize and compare food production practices between traditional backyard poultry systems (BPS) and those with differentiated attributes (BPS-DA) in Central Chile. By integrating structured surveys with direct observational methods, our findings provide an empirical foundation for assessing food safety risks in informal animal production systems and guiding the development of targeted public health and veterinary policies.

2. Materials and Methods

2.1. Study area and Study Design

A cross-sectional study was conducted among backyard poultry keepers in the Metropolitan Region of Chile. The target population included backyard systems with a maximum of 50 birds per household. Due to the informal and often sensitive nature of poultry slaughter practices [20,38], and

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limited information on the geographic distribution of these systems, a non-probabilistic convenience sampling strategy was employed [39,40].

Collaboration was established between the Veterinary Epidemiology Unit (EPIFAVET) of the University of Chile and the Local Development Program (PRODESAL), a government initiative that supports small-scale farmers [41]. Two operational types of backyard systems were defined:

(i) Traditional Backyard Systems (BPS): Primarily oriented toward food access, with limited or absent biosecurity measures.

(ii) Differentiated Attribute Systems (BPS-DA): oriented toward personal preferences, sustainability, or hobby farming, often incorporating specific production or motivational attributes.

A total of 50 backyard systems (25 BPS and 25 BPS-DA) were enrolled across four municipalities in Santiago (Figure 1): La Pintana (n=16), La Reina (n=9), Lampa (n=10), and Puente Alto (n=15).

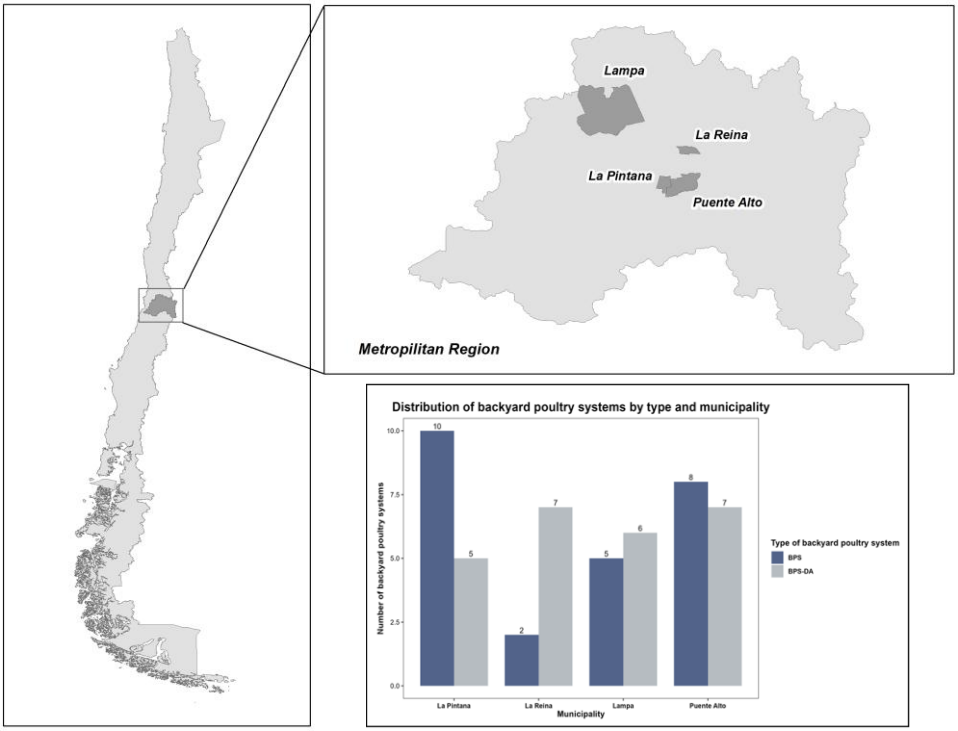

Figure 1. Schemes follow the same formatting Metropolitan Region of Chile and municipalities of origin for the 50 backyard poultry systems included in the study.

2.2. Data Collection

Data were collected between December 2022 and May 2024 through semi-structured, in-person interviews with the person responsible for poultry management. Interviews lasted approximately 20 minutes and included both open- and closed-ended questions to gather information on socioeconomic characteristics, food production practices, biosecurity behaviors, and attributes related to the motivations for keeping poultry and the characteristics of their production systems (hereafter referred to as "motivational" and "productive" attributes) and type and use of animal-source food matrices (Table 1).

To supplement interview data, direct observation was conducted on ten egg collection events and four poultry slaughters. Participants were explicitly asked to carry out the activities as they would typically do, to minimize the potential for observation bias. Of these events, six egg collections

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and one slaughter were video-recorded with prior consent. Differentiated attributes mentioned by respondents were classified into:

(i) Motivational attributes (e.g., hobby farming, companion animals)
(ii) Productive attributes (e.g., free-range systems, local food consumption)

2.3. Variables and Assessment

Variables were classified and defined in structured evaluation tables (Tables 1 and 2), which detailed the assessment method, category, and scoring system for each measured item.

Table 1. Evaluated items: classification, description, and assessment method.

Classification	Evaluated Item	Description	Assessment Method
Socioeconomic	Bird caretaker	Gender of the person responsible for poultry care and management	Closed question
	Education level	Educational background of the caretaker	Closed question
	Household income	Monthly income in relation to the national minimum wage	Closed question
Production Practices	Rearing experience	Time dedicated to poultry rearing	Closed question
	Bird feeding	Use of kitchen scraps, grain supplementation, and water source	Closed question
	Confinement modality	Strict, mixed, or free-range confinement	Closed question
	Bird replacement	Use of own birds or exchange with other producers	Closed question
Food Production	Food matrix	Classification of main poultry products (eggs and/or meat)	Closed question
	Egg collection	Location and time spent collecting eggs	Direct observation, open question
	Poultry slaughter	Slaughter method, bird selection, time, location, and frequency	Direct observation, open question
	Sale or gifting	Frequency and destination of food products	Open question
Biosecurity	Facility hygiene	Frequency of cleaning or disinfection of coops and equipment	Open question
	Disposal of mortalities	Practices such as burial or incineration of dead birds	Open question
	Contact with peri-domestic fauna	Interaction between poultry and surrounding wildlife	Open question
	Access to veterinary services	Access to veterinary care	Closed question
	Medication use	Use of medications, including antimicrobials	Closed and open question

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	Personal protective equipment	Use of gloves, boots, dedicated tools, or other sanitary measures during collection or slaughter	Direct observation, open question
Risk Perception	Hazard recognition	Awareness of pathogens like Salmonella spp. and E. coli as public health threats	Closed question
	Withdrawal time awareness	Familiarity with drug withdrawal periods before consuming animal-source products	Closed question
Storage	Eggs	Storage practices: refrigerated or ambient	Direct observation, open question
	Slaughter products	Storage of meat under refrigeration or ambient conditions	Direct observation, open question
Distribution	Eggs	Distribution practices through sale or gifting	Closed question
	Slaughter products	Distribution practices through sale or gifting	Closed question
Differentiated Attributes	Productive attributes	Practices such as free-range poultry or local food production	Closed question
	Motivational attributes	Perception of poultry as companion animals or hobby farming	Closed question

Table 2. Evaluated items: description, assessment method, and response categories.

Description	Assessment Method	Response Categories
Gender	Closed question	Female / Male / Other
Education level	Closed question	Incomplete/Complete Primary or Secondary / Higher Education
Household income	Closed question	Below / Equal / Above national minimum wage
Rearing experience	Closed question	Less than / Equal to / More than 5 years
Bird feeding	Closed question	Kitchen scraps and/or grain supplementation
Confinement modality	Closed question	Free-range / Mixed / Confined
Bird replacement	Closed question	Own flock and/or external exchange
Food matrix	Closed question	Eggs and/or Meat
Access to veterinary services	Closed question	Yes / No
Medication use	Closed and open question	Yes / No / Which ones

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Awareness of Influenza A virus, *Salmonella spp.* and/or *E. coli* risk	Closed question	Yes / No
Withdrawal period knowledge	Closed question	Yes / No
Egg distribution	Closed question	Sale and/or Gifting
Meat distribution	Closed question	Sale and/or Gifting
Salmonella spp. recognition	Closed question	Yes / No
E. coli recognition	Closed question	Yes / No
Awareness of withdrawal periods	Closed question	Yes / No
Productive attributes	Closed question	Free-range poultry / Local food production
Motivational attributes	Closed question	Companion animals / Hobby farming

2.4. Data Analysis

Quantitative and qualitative data were entered into Microsoft Excel and analyzed using RStudio. Descriptive statistics were calculated as absolute frequencies and proportions. Comparisons between the BPS and BPS-DA groups were made using the Chi-square test for categorical variables and the Student's t-test for continuous variables. A significance level of $p < 0.05$ was applied with 95% confidence intervals.

3. Results

3.1. General and Socioeconomic Characteristics of Backyard Poultry Systems

A total of 50 backyard poultry systems were surveyed: 25 traditional systems (BPS) and 25 with differentiated attributes (BPS-DA). Of the systems, 64% (n = 32) were in peri-urban areas, and 36% (n = 18) in urban settings. In BPS, 80% were peri-urban and 20% urban, whereas among BPS-DA, 48% were urban and 52% peri-urban. Women predominantly manage backyard poultry systems in the Metropolitan Region of Chile. In both conventional (BPS) and differentiated attribute systems (BPS-DA), women were the primary caretakers, accounting for 76% and 84% of respondents, respectively. The average age of female caretakers was slightly higher in BPS (44.6 years; range: 18–60) compared to BPS-DA (40.4 years; range: 18–61). Most caretakers reported extensive experience in poultry rearing, with over 90% of those in BPS and 72% in BPS-DA having more than five years of experience.

Significant socioeconomic differences emerged between the two system types. Caretakers in BPS-DA reported substantially higher educational attainment: 100% had completed formal schooling, and over half (52%) held post-secondary qualifications. In contrast, only 56% of BPS caretakers had completed their basic education, with none reporting higher education. Household income followed a similar pattern. While 84% of BPS-DA respondents reported monthly earnings above the national minimum wage (CLP 500,000 / 500 USD), the majority (76%) of BPS respondents reported earning at or below this threshold—a statistically significant contrast ($p < 0.001$).

Regarding production, eggs were the primary food product across both systems, reported by 100% of BPS and 80% of BPS-DA ($p = 0.059$). However, meat production was exclusively reported in traditional systems (72%), with no reports from BPS-DA, suggesting a fundamental divergence in production goals. Trade practices also varied: BPS respondents more frequently reported informal egg sales (64% vs. 32%), while gifting was more common in BPS-DA (68% vs. 36%), with a statistically significant difference ($p = 0.047$). In both system types, the person responsible for animal care also managed the sale or distribution of products (Table 3).

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Table 3. General and socioeconomic characteristics of backyard poultry systems in the Metropolitan Region of Chile.

Variable	Production System		χ^2	p-value
	BPS (n = 25)	BPS-DA (n = 25)		
Bird caretaker[1]			0.12	0.72
Female	76% (19/25)	84% (21/25)		
Male	24% (6/25)	16% (4/25)		
Caretaker age (years)			—	—
Female	Mean 44.6 (18–60)	Mean 40.4 (18–61)		
Male	Mean 46.3 (41–57)	Mean 39.8 (39–45)		
Poultry rearing experience[2]			2.16	0.14
Less than 5 years	8% (2/25)	28% (7/25)		
5 years or more	92% (23/25)	72% (18/25)		
Educational level[2]				
Completed schooling	56% (14/25)	100% (25/25)	11.65	**0.0006**
Higher education	0% (0/25)	52% (13/25)	14.96	**0.0001**
Household income[3]			15.78	**7.11E-05**
Equal to or below minimum wage	76% (19/25)	16% (4/25)		
Above minimum wage	24% (6/25)	84% (21/25)		
Produced food				
Eggs	100% (25/25)	80% (20/25)	3.55	0.059
Meat	72% (18/25)	0% (0/25)	25.08	**5.48E-07**
Egg distribution (≥ 1×/month)			3.92	**0.047**
Sale[4]	64% (16/25)	32% (8/25)		
Gifting[5]	36% (9/25)	68% (17/25)		

[1] All caretakers were over 18 years old.[2] Refers to the primary caretaker of the birds.[3] Based on the national minimum monthly wage in Chile (~CLP 500,000).[4] Eggs sold informally at least 3 times per month.[5] Eggs gifted at least once per month.

3.2. Productive Characteristics of Backyard Poultry Systems

Significant differences in productive characteristics were observed between traditional backyard poultry systems (BPS) and those with differentiated attributes (BPS-DA) (Table 4). BPS-DA reported a significantly lower average number of birds per household, with a mean of 16.5 birds (range: 4–29; median: 16), compared to 21.7 birds in BPS (range: 7–45; median: 20) ($t = 2.25$, $df = 45.17$, $p = 0.015$). Species diversity also varied: 68% of BPS included other poultry species such as ducks or geese, while only 40% of BPS-DA did so. Pigs (8%) and equines (12%) were exclusively reported in BPS. Additionally, non-productive companion animals, such as dogs and cats, were more common in BPS (52%) than in BPS-DA (36%).

Feeding practices diverged notably between systems. All households in BPS and 80% in BPS-DA used household food scraps as feed. However, while 100% of BPS-DA were also supplemented

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with commercial grains, only 60% of BPS households did so. Regarding water sources, nearly all systems used piped potable water—96% in BPS and 100% in BPS-DA—while one BPS relied on a water tanker truck (4%).

Bird replacement strategies also differed; 88% of BPS-DA sourced replacement birds from their own flock, compared to 72% in BPS. Conversely, 28% of BPS households reported exchanging birds with other producers, whereas this was reported by only 12% of BPS-DA households.

Table 4. Productive characteristics of backyard poultry systems in the Metropolitan Region of Chile.

Variable	Production System		χ^2	p-value
	BPS (n = 25)	**BPS-DA (n = 25)**		
Number of birds [a]	Mean: 21.7 (min 7 – max 45) Median: 20	Mean: 16.5[b] (min 4 – max 29) Median: 16	—	**0.014**
Other bird species (ducks or geese)	68% (17/25)	40% (10/25)	2.89	0.08
Other productive species				
Pigs	8% (2/25)	—		
Equines	12% (3/25)	—		
Other domestic animals	52% (13/25)	36% (9/25)	0.73	0.39
Feeding				
Kitchen leftovers	100% (25/25)	80% (20/25)	3.55	0.059
Grain supplementation	60% (15/25)	100% (25/25)	10.12	**0.001**
Drinking water				
Well water	96% (24/25)	100% (25/25)		
Truck-delivered water	4% (1/25)	—		
Bird replacement			1.12	0.28
Own flock	72% (18/25)	88% (22/25)		
Exchange	28% (7/25)	12% (3/25)		

[a] Situation not reported in BPS at the time of survey [b] t = 2.2527; df = 45.166; p = 0.01459.

3.3. Biosecurity Practices and Perception of Health Threats

Infrastructure characterization revealed a significantly higher presence of functional poultry houses in BPS-DA systems, where 76% reported having at least one coop, compared to only 32% in BPS (χ^2 = 8.05; p = 0.004). Regarding confinement practices, 52% of BPS and 64% of BPS-DA implemented a mixed system (combining nighttime confinement with free-ranging during the day), showing no significant difference (χ^2 = 0.32; p = 0.56). Strict confinement without outdoor access was reported in 28% of BPS and only 4% of BPS-DA (χ^2 = 3.72; p = 0.053), while no confinement was reported in 20% and 32%, respectively (χ^2 = 0.41; p = 0.51).

High levels of contact with peri-domestic fauna were reported in both systems; 88% in BPS and 96% in BPS-DA, mainly involving passerine birds (χ^2 = 3.72; p = 0.053).

Sanitation practices differed significantly between systems. While 88% of BPS-DA participants cleaned their facilities at least once a month, only 36% of BPS reported the same (χ^2 = 12.2; p = 0.0004). Burial was the predominant method for carcass disposal in BPS-DA (100%), compared to 68% in BPS

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($\chi^2 = 7.29$; $p = 0.006$). Additionally, incineration of dead birds was reported by 33% of BPS participants, a practice not observed in BPS-DA ($\chi^2 = 4.73$; $p = 0.02$).

Veterinary service access remained low, reported by 32% of BPS and 44% of BPS-DA systems ($\chi^2 = 0.33$; $p = 0.56$). Medication use in the past year—regardless of prescription—was reported by 24% of BPS and 36% of BPS-DA ($\chi^2 = 0.38$; $p = 0.53$), while specific use of antimicrobials was low (8% in BPS vs. 20% in BPS-DA; $\chi^2 = 0.66$; $p = 0.41$). Notably, none of the respondents could specify the type of drug or antimicrobial used.

Regarding perception of health threats, 76% of BPS-DA participants identified Salmonella as a risk, compared to 52% in BPS ($\chi^2 = 2.17$; $p = 0.14$). Recognition of E. coli as a hazard was even lower: 28% in BPS-DA and 16% in BPS ($\chi^2 = 0.46$; $p = 0.49$). Awareness of the concept of withdrawal period was limited, reported by only 12% of BPS-DA and 4% of BPS participants ($\chi^2 = 0.27$; $p = 0.6$). Finally, contact between poultry and individuals outside the household was significantly more frequent in BPS-DA (60%) than in BPS (28%) ($p = 0.04$).

Full details on biosecurity and risk perception characteristics are presented in Table 5.

Table 5. Biosecurity and health threat perception characteristics of backyard poultry systems (BPS and BPS-DA) in the Metropolitan Region of Chile.

Variable	BPS (n=25)	BPS-DA (n=25)	χ^2	p-value
Functional coops	32% (8/25)	76% (19/25)	8.05	**0.004**
Bird confinement modality				
Strict confinement	28% (7/25)	4% (1/25)	3.72	0.053
No confinement (free)	20% (5/25)	32% (8/25)	0.41	0.51
Mixed[1]	52% (13/25)	64% (16/25)	0.36	0.56
Cleaning or disinfection of facilities[2]	36% (9/25)	88% (22/25)	12.22	**0.0004**
Use of feces as fertilizer	72% (18/25)	56% (14/25)	0.78	0.37
Disposal of dead birds				
Birds are buried	68% (17/25)	100% (25/25)	7.29	**0.006**
Birds are burned	32% (6/25)	—	4.73	
Contact with peridomestic fauna	72% (18/25)	96% (24/25)	3.72	0.053
Contact with non-household individuals[3]	28% (7/25)	60% (15/25)	3.97	**0.04**
Access to veterinary services	32% (8/25)	44% (11/25)	0.38	0.56
Use of medications[4]	24% (6/25)	36% (9/25)	0.53	0.53
Use of antimicrobials[5]	8% (2/25)	20% (5/25)	0.66	0.45
Responsible Adult (RA) knows concept of withdrawal period	4% (1/25)	12% (3/25)	0.27	0.6
RA recognizes Salmonella spp. as a hazard	52% (13/25)	76% (19/25)	2.17	0.14
RA recognizes E. coli as a hazard	16% (4/25)	28% (7/25)	0.46	0.49

[1]Mixed confinement: Nighttime confinement with free roaming during the day2Situation not reported in the BPS[3]With a frequency of at least once per month[4]Refers to individuals who are not part of the household[5]With or without veterinary supervision in the past year.

3.4. Characterization of the Motivational and Productive Profile of BPS-DA

3.4.1. Motivational Attributes

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Among the 25 characterized BPS-DA respondents, 76% indicated that their involvement in backyard poultry keeping was primarily motivated by a desire to engage in the activity as a hobby. Additionally, 60% of the systems reported viewing poultry as companion animals. These motivations emerged as key defining attributes of the BPS-DA. During field interviews, affective interactions between the caretakers and their birds were observed, including physical expressions of affection (e.g., hugging or kissing the birds) and verbal communication mimicking conversations.

3.4.2. Productive Attributes

In 80% of the BPS-DA, the main productive goal was to obtain locally sourced food that aligned with the household's specific taste preferences. The remaining 20%, although maintaining egg production, reported not consuming the eggs due to personal dietary choices, instead choosing to give them away. Furthermore, 68% of the BPS-DA adopted a free-range poultry management model, which was perceived as the most natural and welfare-oriented practice for poultry rearing.

3.5. Characteristics of Food Production Practices

3.5.1. Egg Production Practices

In both backyard poultry systems (BPS and BPS-DA), adult women (over 18 years) were the primary individuals responsible for egg collection, accounting for 76% in BPS and 84% in BPS-DA ($\chi^2 = 0.125$; $p = 0.72$).

However, the egg collection sites differed significantly. In BPS-DA, 92% of respondents reported collecting eggs primarily from nest boxes and inside coops, compared to 64% in BPS. Conversely, collection from open yards was more frequent in BPS (36%) than in BPS-DA (8%) ($\chi^2 = 4.19$; $p = 0.04$). In a subset of 10 systems (5 BPS and 5 BPS-DA), direct observations were conducted, revealing that the nest boxes in BPS-DA were visibly cleaner than those in BPS. In BPS, unconventional laying sites were noted, such as hidden areas in the yard filled with discarded materials, including wood scraps, metal sheets, and old tires—spaces that seemed to be favored by hens for nesting.

The time dedicated to collection was similar across systems, with 84% of BPS-DA and 72% of BPS reporting that they completed the process within 10 minutes ($\chi^2 = 0.46$; $p = 0.49$). These durations were also confirmed through video documentation and field observations.

Biosecurity practices during egg collection varied. Exclusive-use footwear was significantly more common in BPS-DA (55%) than in BPS (12%) ($\chi^2 = 6.09$; $p = 0.01$). No system reported the use of gloves. Mask use was mentioned by 10% of BPS-DA respondents, but not by any BPS respondents ($\chi^2 = 0.52$; $p = 0.47$). Handwashing after collection was reported by 32% of BPS-DA and 24% of BPS ($\chi^2 = 0.99$; $p = 0.75$), though this was not observed during field visits.

Storage practices also differed. In BPS-DA, 64% of respondents reported refrigerating eggs immediately after collection, versus only 20% in BPS ($\chi^2 = 8.21$; $p = 0.004$). Washing eggs before storage was reported by 44% of BPS-DA and 28% of BPS ($\chi^2 = 0.78$; $p = 0.37$), although this was not corroborated through observation.

Finally, informal egg sales were significantly more common in BPS, with 64% selling eggs at least three times per month to support household income, compared to 32% in BPS-DA ($\chi^2 = 3.92$; $p = 0.04$). Gifting eggs was frequent in both systems: 44% in BPS and 36% in BPS-DA ($\chi^2 = 0.8$; $p = 0.77$).

Detailed practices are summarized in Table 6 and Figure 2.

Table 6. Practices associated with egg production in BPS and BPS-DA in the Metropolitan Region of Chile.

Variable	Production system			
	BPS (n=25)	BPS-DA (n=25)	χ^2	p-value
Person in charge				
Woman	76% (19/25)	84% (21/25)	0.125	0.72

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Variable	Production system			
Collection site				
Nest boxes	64% (16/25)	92% (23/25)	4.19	**0.04**
Household yard	36% (9/25)	8% (2/25)		
Collection time				
10 minutes or less	72% (18/25)	84% (21/25)	0.46	0.49
Biosecurity during collection				
Use of container	24% (6/25)	16% (4/25)	0.12	0.7
Gloves	—	—	—	—
Masks	—	8% (2/25)	0.52	0.47
Exclusive-use footwear	12% (3/25)	55% (12/25)	6.09	**0.01**
Handwashing after collection	24% (6/25)	32% (8/25)	0.99	0.75
Egg washing before storage	28% (7/25)	44% (11/25)	0.78	0.37
Storage				
Refrigeration	20% (5/25)	64% (16/25)	8.21	**0.004**
Egg sale or gifting				
Sale[1]	64% (16/25)	32% (8/25)	3.92	**0.04**
Gift[2]	44% (11/25)	36% (9/25)	0.8	0.77

[1] At least 3 times per month[2] At least once per month— Data not reported for SPT.

3.5.2. Slaughtering Practices

Among the 25 BPS characterized as subsistence systems (BPS), 60% (n=15) reported performing on-site poultry slaughter. Of these, four systems allowed direct observation, and one consented to video documentation. In the 15 SPT systems practicing slaughter, adult women were the primary actors in 87% of cases, while 13% reported the involvement of adult men from the same household. Women conducted all slaughter events observed.

Based on self-reported data, the average number of birds slaughtered per year was 1.6 (range: 1–3). A frequency of at least one slaughtering event per month was reported by 73% of the systems, while the remaining 27% performed it at least once every two months. Selection criteria for birds primarily included ease of capture (53%), with a preference for birds closest to the handler or easiest to catch. Other criteria included the removal of roosters (27%) and older hens with decreased productivity (20%). In all directly observed events, hens were selected based on ease of capture.

Regarding the method of slaughter, 93% of respondents used cervical dislocation, describing it as a rapid technique that minimizes bird suffering. Only one household (7%) reported using jugular cutting, citing family tradition. All observed cases used cervical dislocation. The location for slaughtering varied: 73% of households performed it in non-designated areas of the backyard, while 27% used a specific area prepared for this purpose. Across all systems, the slaughtering process was completed in two minutes or less, as confirmed by direct observations.

Scalding practices were reported to occur primarily in the kitchen (73%) or in the backyard (27%), always involving the use of hot water. In kitchen-based scalding, all respondents disposed of feathers in sealed bags along with other household waste. In backyard scalding, 67% used similar disposal, while 33% discarded feathers in open waste piles or incinerated them. Of the four observed

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households, three performed scalding in the kitchen and one in the yard, all disposing of feathers with regular garbage.

Biosecurity practices during slaughter were generally limited. No use of gloves or face masks was reported or observed in any system. Only the household that used jugular cutting reported wearing exclusive-use footwear. In all systems, a knife was the primary tool used, and 80% also employed a cutting board. Exclusive utensils for slaughtering were available in only 13% of systems; the remaining 87% used regular kitchen tools shared with other domestic tasks. All observed systems used both a knife and a cutting board. In three cases, evisceration occurred in the kitchen, and in one, it took place in the yard. The slaughter process began with decapitation, followed by removal of the limbs and evisceration. During backyard slaughtering, contamination of the soil with blood and intestinal content was observed, and in one case, other birds were seen pecking at discarded remains. Although all respondents reported rinsing tools with water, disinfection practices were not described. Post-slaughter handwashing with soap and water was mentioned by 47% of participants, but this behaviour was not directly observed.

Regarding carcass storage, 80% of households refrigerated the meat, while 20% left it at room temperature in the kitchen due to immediate or near-future consumption. Finally, 13% of the households reported selling carcasses to nearby neighbours at least twice per year, while 7% reported giving them as gifts to relatives or members of their social circle. Details are presented in Table 7.

Table 7. Slaughtering practices in backyard poultry systems (BPS) characterized in the Metropolitan Region of Chile.

Variable	Production System	BPS (n = 25)
Reports slaughtering poultry	Yes	60% (15/25)
Person responsible	Woman	87% (13/15)
Slaughter frequency		
Annual average of birds slaughtered		1.6 (min 1 - max 3)
At least once a month		73% (11/15)
At least once every two months		27% (4/15)
Criteria for bird selection		
Ease of capture		53% (8/15)
Roosters		27% (4/15)
Older birds (reduced productivity)		20% (3/15)
Slaughter method		
Cervical dislocation		93% (14/15)
Jugular cut		7% (1/15)
Slaughter location		
Designated area in backyard		27% (4/15)
Undesignated backyard area		73% (11/15)
Slaughter time	≤ 2 minutes	100% (15/15)
Scalding location		
Kitchen		73% (11/15)
Household yard		27% (4/15)
Biosecurity during scalding		

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Feathers disposed in appropriate bags		33% (5/15)
Feathers discarded in the environment		67% (10/15)
Evisceration location		
Kitchen		73% (11/15)
Backyard (designated area)		27% (4/15)
Evisceration time	≤ 20 minutes	100% (15/15)
Biosecurity during slaughter		
Gloves		—
Face mask		—
Apron or overalls		—
Exclusive footwear		7% (1/15)
Exclusive utensils for slaughter		13% (2/15)
Knife		93% (14/15)
Scissors		7% (1/15)
Cutting board		80% (12/15)
Utensil cleaning		100% (15/15)
Utensil disinfection		—
Handwashing after slaughter [1]		47% (7/15)
Hand disinfection after slaughter		—
Carcass storage		
Refrigeration		80% (12/15)
Ambient temperature		20% (3/15)
Carcass disposal: sale or gifting		
Sale [2]		13% (2/15)
Gift [3]		7% (1/15)

[1] Using water and soap [2] At least twice per year [3] To relatives and/or social circle.

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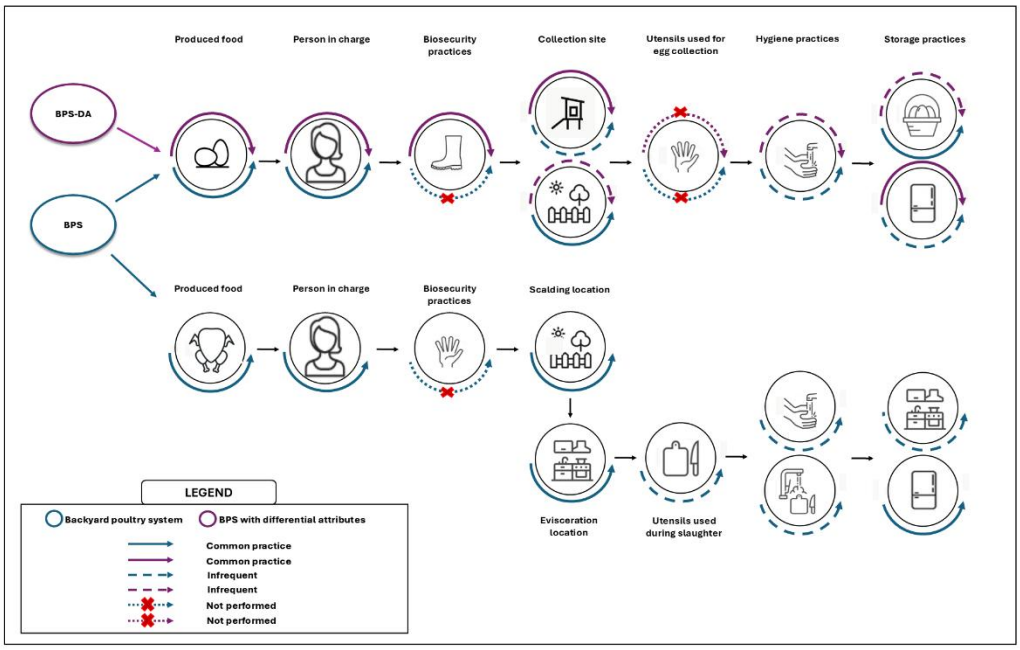

Figure 2. Conceptual framework of poultry meat production practices in backyard poultry systems characterized in the Metropolitan Region of Chile.

4. Discussion

Backyard poultry systems (BPS) serve as a cornerstone of food security for millions of families worldwide and are currently exhibiting a growing diversification of their purposes beyond traditional subsistence. This study offers a comparative characterization of two types of backyard poultry systems in Chile's Metropolitan Region, revealing significant differences in production practices, motivations, and socioeconomic profiles that align with — yet also nuance — global patterns.

Eggs emerged as the primary food output across both systems, consistent with findings that highlight egg production as a principal motivation in small-scale poultry farming [3,42–44]. Women led the management of these systems, often with over five years of experience in the field. This gendered dimension has been widely recognized both globally [3,5,45] and locally [30–32], reinforcing the imperative of incorporating gender-sensitive approaches into biosecurity and production strategies.

Key operational distinctions were observed in egg collection practices. BPS-DA relied on designated nest boxes within henhouses, whereas SPT systems more commonly used nonspecific areas of the yard — including improvised sites such as old tires ($p = 0.04$). Hygiene and biosecurity measures were generally scarce across both systems, echoing international and Chilean literature [4,5,30–32,46]. However, henhouse functionality ($p = 0.004$), monthly cleaning routines ($p = 0.0004$), and the use of dedicated footwear ($p = 0.01$) were significantly more prevalent in the BPS-DA group. These practices have been demonstrated to lower microbial loads and reduce risks of infectious and zoonotic diseases [9,47].

Storage practices further illustrate disparities. BPS-DA systems frequently refrigerate eggs post-collection, in contrast to ambient storage in kitchen baskets in BPS households ($p = 0.004$), a practice that increases microbial risk due to temperature fluctuation and pathogen proliferation, especially *Salmonella* spp. [48]. Some households reported pre-storage egg washing, which can damage the cuticle and allow bacterial infiltration [48]. Informal egg commercialization was more common among BPS systems. In contrast, DPS-DA respondents preferred gifting within their social networks ($p = 0.047$), suggesting that they may have differing exposure levels to food safety risks depending on the handling and distribution pathways.

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Another distinctive feature of BPS-DA systems is the emphasis on proximity foods (80%) and free-range poultry rearing (68%). Proximity foods are valued for both their geographical closeness—the short distance between production and consumption—and their value-based proximity, which reflects the importance of origin and quality in food choices [49–51]. Backyard production, managed directly by household members without intermediaries, ensures full traceability and fosters a sense of food safety. Eggs are consumed shortly after being laid, which enhances their perceived freshness and quality. Additionally, these foods often carry symbolic and functional meanings, reinforcing their cultural value in household food systems [49].

This connection between value and proximity is frequently cited as a primary motivation for keeping backyard poultry [7,52–54]. Free-range rearing further supports this model by promoting natural behaviors and social acceptance of animal welfare practices [55–57]. It is widely recognized as a hallmark of alternative poultry systems [57–59]. However, this production approach also increases birds' exposure to environmental pathogens due to their greater interaction with the surroundings [55], underscoring the need for informed management and biosecurity practices to mitigate zoonotic risks.

A critical finding was the exclusive occurrence of poultry slaughter in BPS systems (60%). This practice, driven by cultural heritage and protein Access [3,52,60,61], contrasted with BPS-AD motivations rooted in companionship (60%) and hobbyist engagement (76%), as seen in non-conventional systems in North America and Europe [26,57,58,62,63]. These differences may explain the absence of slaughter in BPS-DA systems. Furthermore, higher levels of education (52%) and income (84%) in BPS-DA households — versus 0% and 24% in BPS — align with evidence that greater socioeconomic status correlates with more diversified consumption patterns and reduced reliance on meat [31,64].

In Chile, official slaughtering must occur in authorized establishments [65] under the supervision of the Agricultural and Livestock Service (SAG); however, such regulations are often unknown or unattainable for most backyard producers [31]. This regulatory void leaves informal slaughter unmonitored and without sanitary oversight, despite its role as a zoonotic exposure point. National studies have confirmed the presence of zoonotic pathogens in BPS, including a 4.6% prevalence for Salmonella spp. [33], 7.7% for STEC [34], and 43.5% seroprevalence for avian influenza [36].

Observed slaughter practices exacerbated these risks. Evisceration often occurred directly on the ground, spreading blood and intestinal contents and attracting other animals. Biosecurity was minimal: handwashing, tool disinfection, and exclusive utensils were rarely reported. Biological waste, including feathers and viscera, was often discarded improperly, potentially contaminating soil and water. These issues parallel reports from Bangladesh, Peru, Brazil, and Ecuador [27–29,61]. While Chile's public health infrastructure differs, U.S. outbreaks linked to backyard poultry — including 1134 confirmed Salmonella cases and two deaths in 2019 alone [66]— illustrate how asymptomatic birds can pose substantial health risks.

Crucially, there were significant knowledge gaps. Awareness of the withdrawal period for antimicrobial residues was minimal (4% in BPS; 12% in BPS-DA), and while Salmonella was widely known, fewer respondents recognized *E. coli* as a risk (16% BPS; 28% BPS-DA). These findings are especially worrying considering the previously described evidence on the circulation of both agents and the presence of antimicrobial residues in foods from backyard systems in central Chile [33,34,67,68]. This knowledge-perception disconnect highlights the need for targeted education that extends beyond awareness and promotes practical measures, such as hand hygiene, tool separation, and safe waste management.

In light of this scenario, integrating backyard poultry production into existing health and regulatory frameworks is essential to advance the protection of both public and veterinary health. In a comparative analysis, [60] identified five types of regulatory frameworks applicable to these systems; (i) silent frameworks, which lack entirely specific regulations; (ii) discrete frameworks, where other laws indirectly recognize the practice without explicit rules; (iii) uneven frameworks,

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which vary depending on the animal species or sex; (iv) conditional frameworks, which allow slaughter under certain circumstances; and (v) prohibitive frameworks, where the practice is expressly forbidden.

This typology provides a helpful lens for examining how different countries have approached backyard poultry regulation. For example, the United States employs a conditional and uneven framework, as rules vary by state, animal species, and sanitary conditions. Home slaughter is permitted, but only under certain restrictions [60]. A more recent study in Colorado revealed a steady increase in municipal ordinances permitting poultry keeping in urban areas; however, fewer than half of the reviewed ordinances addressed slaughter explicitly, and very few included provisions for veterinary care, hygiene requirements, or disease prevention [24]. In Canada, particularly in the province of Ontario, the framework is also conditional: home slaughter is permitted for personal consumption, provided that no commercialization occurs and basic hygiene standards are met [62]. In New Zealand, the approach is discrete, as there are no specific laws governing backyard systems; however, other general statutes permit home slaughter within certain limits [69]. In Turkey, the recent expansion of backyard poultry in residential areas has prompted the development of regulations targeting issues such as animal density, noise, and health risks [70].

Several studies have emphasized that the high heterogeneity of backyard systems—regarding their goals, scale, and practices—poses a significant regulatory challenge for both sanitary oversight and the development of well-adapted public policies [13,44,60]. According to [60] typology, the Chilean regulatory framework for backyard poultry production would fall under a discrete framework. More specifically, regarding slaughter practices, there are no specific regulations or any provisions that formally acknowledge this activity. The absence of tailored legal norms for this production reality limits both enforcement and technical guidance, leaving these practices outside the scope of official control. Combined with the lack of official registries, this gap poses a significant barrier to designing effective and context-sensitive public health strategies.

This study has limitations, including a small sample size and potential biases in cross-cultural comparisons. However, it also has several strengths. The combined use of direct observation and standardized instruments provided detailed insights into underexplored and informal practices. Furthermore, it offers the first operational distinction between two types of backyard poultry systems in Chile, establishing a baseline for more nuanced policy development and targeted interventions.

To effectively mitigate the food safety and public health risks associated with backyard poultry systems, it is essential to advance toward the formal recognition and integration of these systems within national sanitary frameworks. A foundational step in this process involves encouraging the registration of families engaged in backyard production, particularly given the lack of official records and the general lack of awareness about their geographic distribution. Strengthening access to veterinary services must also be prioritized, especially for vulnerable and subsistence producers who currently operate with minimal technical support. Educational strategies should be developed not merely to raise awareness, but to build practical skills in hygiene and biosecurity—emphasizing practices such as proper handwashing, the use of exclusive utensils, safe egg collection and storage, and the adequate disposal of biological waste. Recognizing the distinct characteristics and risks posed by both traditional and alternative backyard systems will enable the design of more context-sensitive public health interventions. Ultimately, the institutional integration of backyard poultry production has the potential to promote safer and more sustainable food systems that align with the socio-productive diversity observed in urban and peri-urban settings in Chile.

5. Conclusions

The comparative characterization of backyard poultry systems in the Metropolitan Region of Chile reveals a wide diversity of practices, motivations, and risk levels that must be acknowledged in the development of public policies. Findings from this study, based on direct observation and an operational differentiation of production systems, provide an empirical foundation to support such

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policy recommendations. Unsupervised slaughter, improper egg handling, and poor waste management emerge as critical points of zoonotic exposure.

Among all the practices observed, slaughter revealed the most critical biosecurity shortcomings. The use of household utensils, lack of basic hygiene, and environmental exposure to blood, viscera, and other fluids reflect a high level of sanitary vulnerability. The disposal of these residues in open areas may facilitate access by other animals and contribute to the spread of pathogens such as avian influenza, Salmonella spp., or *E. coli*. These practices not only compromise the safety of the food produced but also pose a tangible risk to both human and animal health in shared environments.

Considering this reality, it is essential to move toward a regulatory framework that formally recognizes backyard production, establishing minimum biosecurity standards and appropriate monitoring mechanisms tailored to local contexts. Simultaneously, there is a need for practical and culturally relevant educational strategies that reinforce handwashing, the use of dedicated slaughtering utensils, hygienic egg collection, and safe waste disposal. These interventions must consider the producers' specific motivations and practices and be supported by accessible veterinary technical assistance. Only through an intersectoral and context-sensitive approach will it be possible to integrate these systems into effective sanitary governance and progress toward safe, sustainable, and socially recognized poultry production.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

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