Afro-Asian Journal of Scientific Research (AAJSR)
المجلة الأفروآسيوية للبحث العلمي (AAJSR)
E-ISSN: 2959-6505
Volume 3, Issue 1, January - March 2025
Page No: 232-241
Website: https://aajsr.com/index.php/aajsr/index
SJIFactor 2024: 5.028 ISI 2024: 0.580 معامل التأثير العربي (AIF) 2024: 0.74

Knowledge, Attitudes, and Practices of Antimicrobial Use among Livestock Farming in Nalut Region, Libya

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معارف ومواقف وممارسات استخدام مضادات الميكروبات لدى مربي الماشية في منطقة نالوت، ليبيا

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Received: December 10, 2024	Accepted: January 16, 2025	Published: February 10, 2025

Abstract:
The widespread and indiscriminate use of antimicrobials in animal production is the primary contributor to antimicrobial resistance, which has become an increasing concern for public and animal health in developing countries such as Libya. This research aims to assess the knowledge, attitudes, and practices (KAP) regarding antimicrobial use among a sample of livestock breeders in the Nalut region of northwestern Libya. The study adopted a descriptive-analytical methodology for data analysis. A questionnaire was designed as the primary tool to collect the required data and information and was distributed to a random sample of 77 breeders. The results revealed that the majority of the study sample were male (89.6%), with the highest percentage of animals raised being sheep (79.2%), followed by poultry (49.4%). It was observed that 65% of the breeders rely on the use of antibiotics for their animals. The findings also indicated that 54% of the breeders lack information about antimicrobial residues in animal products, and 50% are unaware of the risks associated with the overuse of antimicrobials. Conversely, it was noted that 52% are unfamiliar with the concept of the withdrawal period for antimicrobials. Additionally, 75% emphasized the necessity of a legal framework to regulate the use of these substances. Among the concerning practices revealed by the results, 65% of the breeders obtain antimicrobials without a prescription, and 42% use them without medical consultation. Furthermore, 66% do not read the instructions for use or check the expiration dates, 27% use antimicrobials for prevention, 23% as growth promoters, and 62% do not observe the critical withdrawal period for antimicrobials in animal products. These findings underscore the urgent need for immediate intervention to enhance breeders' knowledge and attitudes toward antimicrobials and to curb irresponsible practices in their use. The study provided a set of recommendations, including targeted strategies such as awareness campaigns, training programs, and government initiatives to ensure the appropriate use of antimicrobials and mitigate their health risks.

Keywords: Antimicrobial use, Livestock breeders, Knowledge, Nalut, Libya.

الملخص
يعد الاستخدام الواسع النطاق والعشوائي لمضادات الميكروبات في الإنتاج الحيواني المساهم الرئيسي في مقاومة مضادات الميكروبات والتي أصبحت مصدر قلق متزايد للصحة العامة والحيوانية في البلدان النامية مثل ليبيا، يهدف هذا البحث إلى تقييم معارف ومواقف وممارسات استخدام مضادات الميكروبات لدى عينة من مربي الماشية في منطقة نالوت شمال غرب ليبيا، اعتمدت الدراسة المنهج الوصفي التحليلي للبيانات، تم تصميم استبانة كأداة للحصول على البيانات والمعلومات

المطلوبة وتم توزيعها على عينة عشوائية بلغت (77) مربي، وأظهرت النتائج أن معظم أفراد عينة الدراسة من الذكور (89.6%)، وكانت أعلي نسبة للحيوانات التي يتم تربيتها للأغنام (79.2%) تليها الدواجن بنسبة (49.4%)، ولوحظ أن (65%) من المربين يعتمدون على استخدام المضادات الحيوية لحيواناتهم، كما كشفت النتائج بأن (54%) ليس لديهم معلومات حول بقايا مضادات الميكروبات في المنتجات الحيوانية وأن (50%) لا يدركون مخاطر الإفراط في استخدامها وبالمقابل لوحظ بأن (52%) ليس لديهم علم بمفهوم فترة سحب المضادات الحيوية. كما أكد (75%) على ضرورة وجود إطار قانوني لتنظيم استخدام هذه المواد. ومن الممارسات الخطيرة التي كشفت عنها النتائج أن (65%) من المربين يحصلون على مضادات الميكروبات بدون وصفة طبية والاستخدام بدون استشارة طبية (42%)، عدم الاطلاع على تعليمات الاستخدام والصلاحية (66%)، الاستخدام للوقاية (27%)، كمنشطات للنمو (23%)، عدم مراعاة الفترة الأزمة لانسحاب المضادات الحيوية من المنتجات الحيوانية (62%). تؤكد هذه النتائج على الحاجة الملحة لتدخل السريع لتعزيز معارف ومواقف المربين تجاه مضادات الميكروبات والحد من الممارسات الغير مسؤولة في استخدامها. قدمت الدراسة مجموعة من التوصيات تشمل إستراتيجيات موجهة كحملات التوعية، برامج تدريبية، ومبادرات حكومية لضمان الاستخدام المناسب للمضادات الميكروبات وتخفيف مخاطرها الصحية.

الكلمات المفتاحية: استخدام مضادات الميكروبات، مربي الماشية، المعارف، نالوت، ليبيا.

Introduction

Antibiotics are an indispensable component of farm animal husbandry, employed for disease treatment and control, as well as growth promotion [1]. The escalating global demand for animal protein for human consumption has led to an unprecedented surge in animal production, with projections indicating a 67% increase in global antimicrobial consumption by 2030 [2]. Despite the historical benefits of antimicrobials in animal health, their increased use, particularly for non-therapeutic purposes, is a major driver of antimicrobial resistance (AMR). These antimicrobials leave residues in animal products (meat, milk, eggs, honey, etc.), posing a risk to human health.

The presence of these residues is attributed to the imprudent use of antimicrobials, such as non-compliance with drug withdrawal periods, excessive dosages, feed contamination, and the use of unauthorized drugs, thus threatening food safety and public health [3]. As recommended by the American Veterinary Medical Association (AVMA) [4], "judicious use of antimicrobials in food-producing animals" should target antimicrobial use only when essential for treating, preventing, and controlling diseases with a confirmed diagnosis. Contrary to this recommendation, antimicrobials are used indiscriminately in the animal food chain worldwide. Locally, several studies have revealed the presence of residues of antimicrobials and drugs such as tylosin, erythromycin, ampicillin, amoxicillin, tetracycline, and oxytetracycline in various animal products (poultry, cattle, camel and cow's milk) to levels exceeding permissible limits [5-7].

Notably, long-term consumption of these products, even within maximum residue limits, can contribute to the development of AMR. Food control plays a crucial role for livestock farmers. The food control system in any country should be effective and ensure food safety and quality. Despite notable efforts to align national standards with international standards in Libya, the 1973 Public Health Law has not yet been updated, laboratory support services are inadequate, reference laboratories for sample testing have not been accredited, and food inspections are not conducted on a risk analysis basis, making it difficult to determine the extent of compliance of food products with Libyan legislation [8].

In light of the aforementioned facts, continuous assessment of knowledge, attitudes, and practices (KAP) of farm animal breeders regarding antimicrobial use in animal production has become crucial to adapt appropriate intervention strategies to address this local issue. This study not only provides a database but also contributes to raising public awareness about healthy and safe food. To our knowledge, there is no evidence or data indicating the existence of studies that have focused on assessing the perspective of Libyan farmers regarding antimicrobial use. Therefore, the main objective of this study was to identify shortcomings and bridge the knowledge gap to reduce antimicrobial misuse and its health consequences.

Material and methods

Study area and duration

This study was conducted in the Nalut region, a Libyan city located in the Nafusa Mountains in northwestern Libya Figure (1). It is 276 kilometers away from the capital, Tripoli, and is located at the geographical coordinates of longitude and latitude (31°52′06″E, 10°58′57″N). It is the second-largest city in the northwestern mountainous range, with a population exceeding 26,300, according to the latest statistics for 2024. The area is known for raising farm animals on a small- and medium-sized family project scale. This study was conducted during the period from January to September 2024.

Figure 1. Displays a map depicting the study location, including the Nalut region in northwestern Libya**.** http://d-maps.com/index.php?lang=en.

Study Sample

A random sample of 80 breeders from the community in the Nalut region was selected for this study. Questionnaires were distributed to them, and only 77 questionnaires were used, while 3 were excluded due to incomplete data.

Data Collection Instruments

The questionnaire form was the main instrument for collecting data related to breeders' knowledge, attitudes, and practices regarding the use of antimicrobials in farm animal breeding. This was done through personal interviews. The questionnaire questions were designed taking into account the questions of the World Health Organization and some previous studies [9]. It was also presented to some specialized academic experts to provide feedback regarding the clarity of the phrases and their suitability for the purpose of the study, and to ensure the internal consistency of the axes' items. The questionnaire is divided into two sections: the first includes 4 items related to demographic information (independent variables), including (gender, age, educational qualification, types of animals raised). The second section includes (dependent variables) and includes three axes consisting of 21 items expressing the level of assessment of the breeder's knowledge, attitudes, and practices, as shown in Table 1.

Table 1. The distribution of questionnaire items across the study axes**.**

SN	Axis	Number of Items
1	Animal breeders' knowledge regarding the use of antimicrobials in animal production.	5
2	Animal breeders' attitudes toward the use of antimicrobials in animal production.	6
3	Animal breeders' practices regarding the use of antimicrobials in animal production.	10
Total		21

Data Management and Statistical Analysis

The descriptive analytical method was used in conducting this study, as it is the appropriate method for this type of study. The Statistical Package for the Social Sciences (SPSS) version 25 was used to analyze and process the collected data. Frequencies and percentages were calculated to describe the study population, and the internal consistency validity of the study axes' items was calculated using Pearson's correlation coefficient at the level ($p \leq 0.05$), ($p \leq 0.01$). Excel was used for graphical representation of results and responses. A three-point Likert scale (Yes, I don't know, No) with weights (3, 2, 1), respectively, was used in constructing the response scale of the sample members on the items of the first axis, and a five-point Likert scale (Strongly agree, Agree, Neutral, Disagree, Strongly disagree) with weights (5, 4, 3, 2, 1), respectively, was used in constructing the response scale of the respondents to the items of the second axis, which deals with descriptive data by converting it into numerical intervals and assigning a score to each interval, through which the level of knowledge and attitudes of the breeder towards the use of antimicrobials in animal production and their health effects can be determined, by calculating the weighted arithmetic mean and the relative weight (which is the

average number of answers for each item expressing the evaluation level, and the value of this average is limited between the intervals, which corresponds to the evaluation level as shown in Tables 2 and 3. Regarding the measurement of responses to the items of the third axis (breeder practices), frequencies and percentages were used to describe the responses of the sample members.

Table 2. Three-point Likert scales for measuring the level of breeder knowledge [10].

Response	Weight	Average Value Between Intervals	Interval Length	Level of Breeder Knowledge
No	1	From 1 to 1.66	0.66	Low Level
I don't know	2	From 1.67 to 2.33	0.66	Medium Level
Yes	3	From 2.34 to 3.00	0.66	High Level

Table 3. Five-point Likert scales for measuring the level of breeder attitudes [10[a]].

Response	Weight	Average Value Between Intervals	Interval Length	Level of Breeder Attitudes
Strongly Disagree	1	From 1 to 1.79	0.79	Very Low Level
Disagree	2	From 1.80 to 2.59	0.79	Low Level
Neutral	3	From 2.60 to 3.39	0.79	Medium Level
Agree	4	From 3.40 to 4.19	0.79	High Level
Strongly Agree	5	From 4.20 to 5.00	0.80	Very High Level

Results and discussion

Reliability of the Questionnaire

Table 4 presents the values of internal consistency for the items of the study instrument axes related to assessing the level of breeders' knowledge, attitudes, and practices regarding the use of antimicrobials in animal production and their health effects by calculating Pearson's correlation coefficient. The correlation coefficient for the items of the three axes was statistically significant at the level ($p \leq 0.05$) and ($p \leq 0.01$). This indicates that there is internal consistency between the items of the measurement instrument used in the study. It is clear from the readings of Table 5 that 89.6% of the study sample members were males, while only 10.4% were females.

Table 4. Average Pearson Correlation Coefficient Between Axis Items and the Total Axis Score.

Axis	Number of Items	Average Correlation Coefficient	Significance Value
First Axis	5	0.658**	0.000
Second Axis	6	0.542**	0.000
Third Axis	9	0.462**	0.000

** Correlation in ($p \leq 0.01$).

Table 5. Demographic Data of Study Sample (N=77).

Variable	Variable Categories	Frequency	Percentage (%)
Gender	Male	69	89.6
	Female	8	10.4
Age group	35 - 45 years	9	11.70
	45 - 55 years	44	57.10
	Older than 55 years	24	31.20
Educational Level	Primary education	5	6.5
	Secondary education	21	27.3
	Bachelors or diploma	50	64.9
	Postgraduate	1	1.3
Type of Animals	Cattle	7	9.1
	Camels	17	22.1
	Sheep	61	79.2
	Poultry	38	49.4
	Other	5	6.5

The lowest percentage of the sample members were aged between 35 and 44 years, reaching 11.7%, and the highest percentage were aged between 45 and 55 years, reaching 57.10%. Regarding the educational level variable, the highest percentage of the sample members had a university education, reaching 64.90%, while the lowest percentage was for postgraduate studies, reaching 1.30%. As for the types of animals raised by the sample members, sheep had the highest percentage, reaching 79.2%, followed by poultry at 49.4%, then camels at 22.1%, then cattle at 9.1%, while other types of animals had the lowest percentage, reaching 6.5%.

Figure 2: Illustrates the analysis of the study sample's responses to the items of the first axis, which represents "the level of knowledge of animal breeders regarding the use of antimicrobials." Knowledge can be divided into four main aspects:

- The impact of antimicrobial use in animal production on human health: The results indicate that (56%) of the participants believe that the use of antimicrobials in animal production negatively affects human health. This indicates a good level of awareness of the potential risks of antimicrobial resistance transfer from animals to humans. However, a significant percentage (44%) either do not know or do not believe in this effect (13% believe there is no effect and 31% do not know). This indicates a knowledge gap that necessitates further awareness and education about this relationship.
- Antimicrobial residues in food of animal origin: Approximately half of the participants (46%) are aware of the presence of antimicrobial residues in food of animal origin. This indicates a moderate level of awareness of this issue. In contrast, more than half of the participants (54%) are either unaware of the presence of these residues (19%) or unsure about it (35%). This points to a critical need to raise awareness of the risks of these residues to consumer health.
- Withdrawal period of antibiotics before slaughter and consumption: About half of the participants (48%) are aware of the concept of the withdrawal period of antibiotics, which is the time that must elapse between the last dose of the antibiotic and the slaughter of the animal. This knowledge is important to ensure that there are no harmful residues in animal products when consumed. However, more than half of the participants (52%) are either unaware of the importance of this period (15%) or unsure of its concept (37%). This indicates the need to educate breeders about the importance of adhering to the withdrawal period to ensure food safety.
- Bacterial resistance as a result of overuse of antimicrobials in animal production (Antimicrobial Resistance - AMR): Exactly half of the participants (50%) realize that the overuse of antimicrobials in animal production leads to the emergence of bacterial resistance to antibiotics, which is a growing global problem. This demonstrates a good understanding of this serious problem. In contrast, half of the participants (50%) are either unaware of this relationship (12%) or unsure of it (38%). This confirms the need for intensive awareness efforts to increase understanding of this problem and its implications.

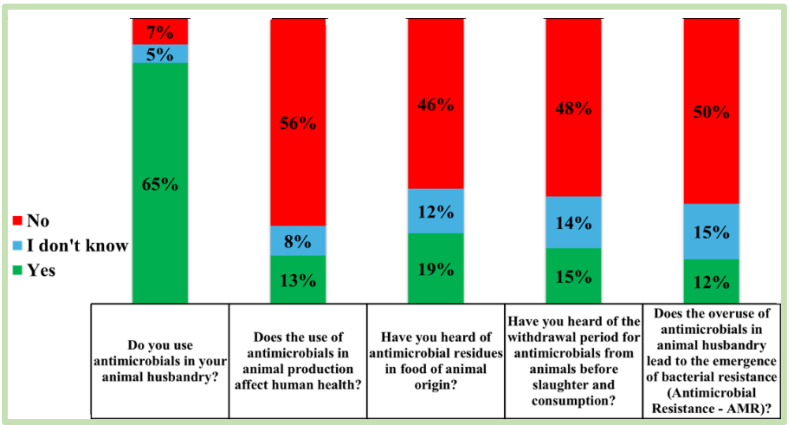

Figure 2. The figure presents Breeders' Knowledge of the Impact of Antimicrobial Use on Human Health, Residues in Food, Withdrawal Periods, and Antimicrobial Resistance.

Figure (3) illustrates the analysis of the study sample's responses to the items of the second axis, which represents "the level of animal breeders' attitudes towards antimicrobial use." The responses regarding the first item of the second axis, which states the breeders' preference for consulting a veterinarian before using antimicrobials, showed that a large percentage of participants, representing 71%

(composed of 40% "Strongly Agree" and 31% "Agree"), prefer consulting a veterinarian before using antimicrobials for their animals. This indicates awareness of the importance of veterinary expertise in this field. While only a small percentage, representing 18% (composed of 12% "Neutral" and 6% "Disagree"), does not prefer this, which calls for some clarification and awareness of the importance of veterinary consultation.

Regarding the second item, which states the necessity of using antimicrobials as growth promoters in animal production, there is a clear division of opinions on this issue. A large percentage, representing 43% (composed of 28% "Disagree" and 15% "Strongly Disagree"), opposes the use of antimicrobials as growth promoters. This is a positive stance reflecting an understanding of the risks of this use. In contrast, a significant percentage, representing 35% (composed of 25% "Agree" and 10% "Strongly Agree"), believes that this use is necessary, which indicates the need for intensive awareness about the negative effects of using antimicrobials as growth promoters, such as increased antimicrobial resistance.

The breeders' attitudes regarding the item stating the possibility of reducing antimicrobial use through appropriate healthcare and vaccination showed that a large percentage of participants, representing 67% (composed of 45% "Agree" and 22% "Strongly Agree"), agree on the possibility of reduction through healthcare and vaccination. This is a positive stance indicating an understanding of the importance of preventive measures. While 25% were neutral and did not clearly state their position, which calls for further clarification about the effectiveness of these measures. Regarding the use of antimicrobials only, when necessary, in animal production, the responses showed that 45% (composed of 26% "Agree" and 19% "Strongly Agree") agree on the necessity of using antimicrobials only when necessary.

This is a positive stance that supports the rational use of antimicrobials. While the neutral percentage was 27% with no clear position, which calls for further clarification about the criteria of "necessity" in antimicrobial use. Regarding the item stating the necessity of having regulations and laws to regulate antimicrobial use in animal production, an overwhelming majority, representing 75% (composed of 45% "Agree" and 30% "Strongly Agree"), supports the existence of regulations and laws to regulate antimicrobial use. This is a positive stance indicating an understanding of the importance of the legal framework in controlling the use of these substances. A small percentage, representing 25%, was neutral. Regarding the need for animal breeders for a guidance program on the use of antimicrobials and drugs, 59% (composed of 31% "Agree" and 28% "Strongly Agree") believe in the need for a guidance program on the use of antimicrobials and drugs. This is considered a positive stance that emphasizes the importance of education and training in this field. In contrast, a significant percentage (27% "Neutral" and 14% "Disagree") did not clearly state their position, which calls for further clarification about the benefits of guidance programs.

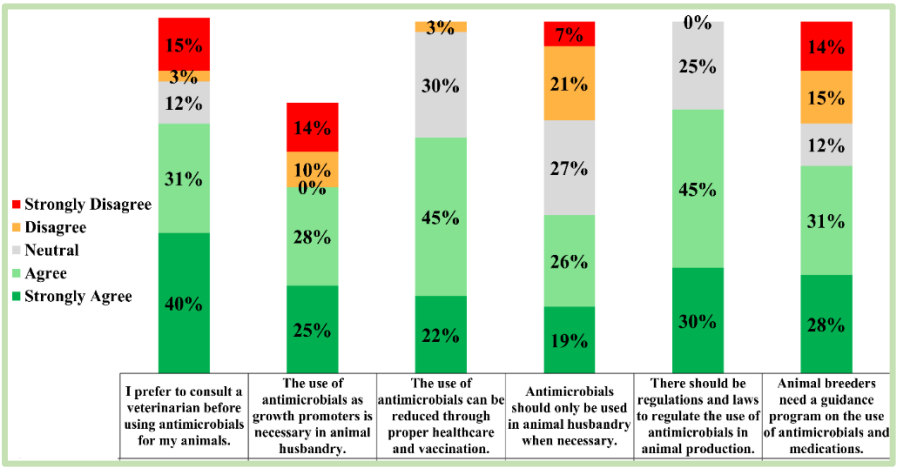

Figure 3. The figure presents analysis of the study sample's responses to the items of the second axis, which represents "the level of animal breeders' attitudes towards antimicrobial use.

Figure 4 illustrates the analysis of the study sample's responses to the first and second items of the third axis, which represents "the level of animal breeders' practices regarding antimicrobial use," and the items relate to consultation and supervision of antimicrobial use in animal production.

1. Who supervises the administration of antimicrobials to your animals? The results indicate that the majority of breeders (58%) rely on veterinary supervision when administering antimicrobials to their animals. This is considered a positive practice, as veterinary supervision ensures the

rational and safe use of these substances. In contrast, a significant percentage (42%) relies on personal supervision in administering antimicrobials. This is considered a dangerous practice, as the lack of specialized medical supervision may lead to overuse or incorrect use of antibiotics, which increases the risk of developing antimicrobial resistance.

2. What did you do when your animals got sick? The results show that more than half of the breeders (53%) resort to consulting a veterinarian when their animals get sick. This is a good practice reflecting awareness of the importance of medical expertise in diagnosing and treating diseases. While a significant percentage (22%) treats the animals themselves. This is also considered a dangerous practice, as incorrect diagnosis and inappropriate treatment may lead to worsening the health condition of the animals and increasing the risk of disease spread. While 20% go to the veterinary clinic, this indicates awareness of the importance of obtaining specialized medical care. A small percentage (4%) does nothing when animals get sick, and this indicates a clear neglect of animal health and calls for an awareness intervention.

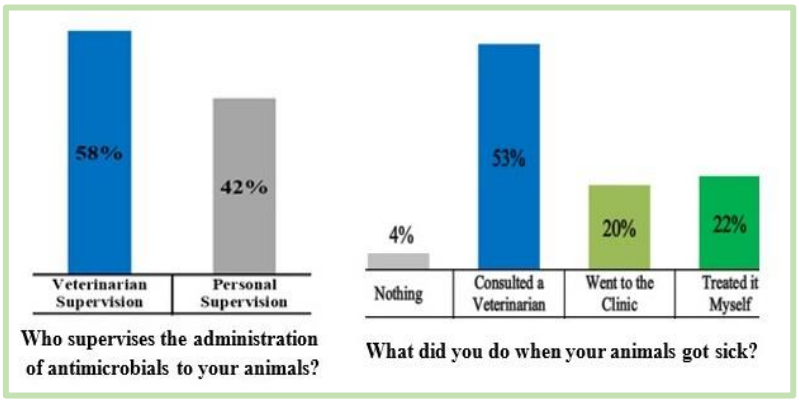

Figure 4. The figure presents analysis of the study sample's responses to the first and second items of the third axis, which represents "the level of animal breeders' practices regarding antimicrobial use," and the items relate to consultation and supervision of antimicrobial use in animal production.

Figure 5 illustrates the analysis of the study sample's responses to the third and fourth items of the third axis. These items address obtaining a prescription before purchasing antimicrobials and reading the usage and expiration instructions before using them.

3. Obtaining a prescription from a veterinarian before purchasing antimicrobials**:** The results indicate that a significant proportion of breeders (65%) do not obtain a prescription from a veterinarian before purchasing antimicrobials. This is a hazardous practice, as purchasing and using antibiotics without a prescription increases the risk of incorrect and excessive use, which significantly contributes to the emergence of antimicrobial resistance (AMR). Conversely, 35% of breeders obtain a prescription before purchasing antimicrobials.

4. Reading the usage and expiration instructions before using antimicrobials on animals: The results show that a large proportion of breeders (66%) do not read the usage and expiration instructions before using antimicrobials on their animals. This is also a risky practice, as not reading the instructions can lead to the use of incorrect dosages or the use of expired products, which can harm animal health and increase the risk of AMR development. Only 34% of breeders adhere to reading the usage and expiration instructions before using antimicrobials. This is a good practice that should be promoted.

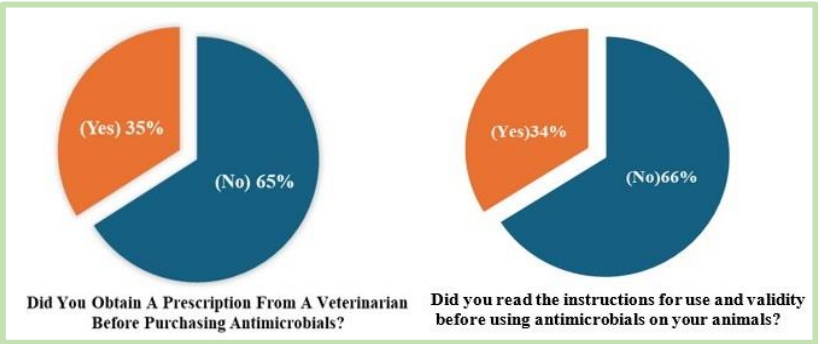

Figure 5. The figure presents analysis of the study sample's responses to the third and fourth items of the third axis. These items address obtaining a prescription before purchasing antimicrobials and reading the usage and expiration instructions before using them.

Figure 6 illustrates the analysis of the study sample's responses to the fifth and sixth items of the third axis. These items address the purpose of using antimicrobials in animal production and their source.
5. Purpose of using antimicrobials on animals: The results show that the vast majority of breeders (49%) use antimicrobials to treat sick animals. This is an expected and natural practice, as antibiotics are used to treat bacterial infections. A considerable proportion (27%) use antimicrobials for prophylaxis (prevention). This is a concerning practice, as the prophylactic use of antibiotics contributes to the emergence of antimicrobial resistance (AMR). The use of antibiotics for prophylaxis should be limited to specific cases and under veterinary supervision. While 23% of breeders use antimicrobials to increase production (growth promotion). This is a dangerous and unacceptable practice, as the use of antibiotics as growth promoters has negative effects on animal, human, and environmental health and significantly contributes to the development of AMR.
6. Source of obtaining antimicrobials for animals: The results show that the main source for breeders to obtain antimicrobials is pharmacies (61%). This requires scrutiny, as antibiotics should be dispensed with a veterinary prescription. Only 30% of breeders obtain antimicrobials from veterinary clinics. This is a better practice than obtaining them from pharmacies without a prescription, as veterinary clinics are supposed to dispense antibiotics under veterinary supervision. A proportion of 7% obtain them from the market. This is very dangerous, as obtaining medications from unreliable sources puts animals at risk and may lead to the use of ineffective, expired, or counterfeit products. A small proportion (2%) obtain them from friends. This is also a completely irresponsible practice, as the safety and efficacy of medications obtained in this way cannot be guaranteed.

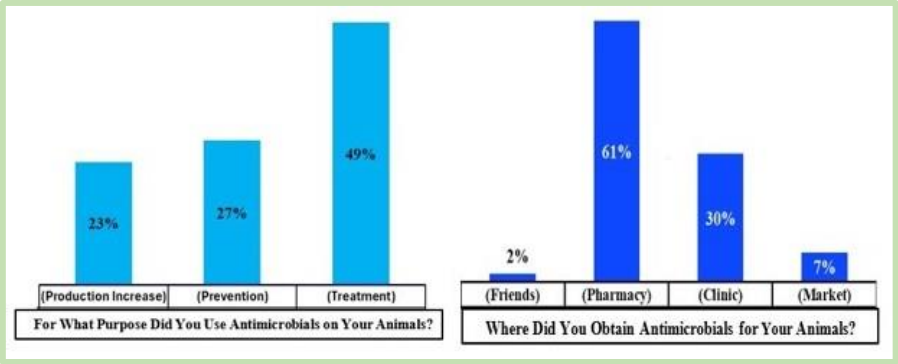

Figure 6. The figure presents the analysis of the study sample's responses to the fifth and sixth items of the third axis. These items address the purpose of using antimicrobials in animal production and their source**.**

Figure 7 illustrates the analysis of the study sample's responses to the seventh, eighth, and ninth items of the third axis, which represents "the level of animal breeders' practices regarding the use of antimicrobials." These items include three aspects related to the withdrawal period of antimicrobials before consuming animal products: meat, milk, and eggs. The withdrawal period is the time that must elapse between the last dose of the antibiotic and the slaughter of the animal or the collection of its milk or eggs, to ensure that there are no harmful residues of the antibiotic in these products when consumed.
Item 7 addresses the time required for consuming animal meat after treatment with antimicrobials. 62% of participants believe that one month is the appropriate period for consuming animal meat after antibiotic treatment. This answer is inaccurate in most cases, as the withdrawal period varies depending on the antibiotic used and the animal species. 13% believe that one week is sufficient, which is also an inaccurate answer. 7% believe that two days are enough, which is a very short and unsafe period in most cases. 18% indicated uncertainty about the answer.
Item 8 addresses the safe period required for consuming animal milk after treatment with antimicrobials. 51% of participants believe that one month is the appropriate period for consuming animal milk after antibiotic treatment. This is an inaccurate answer, as the withdrawal period for milk also varies depending on the type of antibiotic used and the animal species. 14% of participants believe that one week is sufficient, which is also an inaccurate answer. 17% believe that two days are enough, which is a very short and unsafe period. 18% were unsure of the answer.
Item 9 addresses the safe period required for consuming poultry eggs after treatment with antimicrobials. 53% of participants believe that one month is the appropriate period for consuming poultry eggs after antibiotic treatment. This answer is inaccurate, as the withdrawal period for eggs also varies depending on the type of antibiotic. 13% believe that one week is sufficient, which is also an

inaccurate answer. 19% believe that two days are enough, which is a very short and unsafe period. A large proportion of breeders (33%) were unsure of the answer.

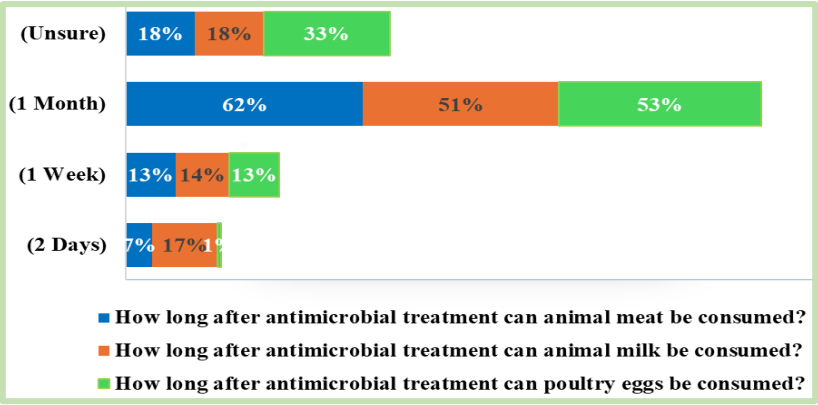

Figure 7. The figure presents the responses of the study participants on items seven, eight, and nine, which relate to the time frame for antimicrobial residue depletion in animal food products.

Conclusion

This study investigated animal breeders' knowledge, attitudes, and practices (KAP) regarding antimicrobial use in livestock production. The findings revealed a mixed picture. While breeders demonstrated awareness of the potential human health risks associated with antimicrobial use and the possibility of residues in animal products, significant knowledge gaps were identified concerning critical aspects such as withdrawal periods and the development of antimicrobial resistance due to overuse. Encouragingly, positive attitudes were observed, including strong support for veterinary consultation prior to antimicrobial administration and opposition to their use as growth promoters. Participants also generally acknowledged the importance of regulatory frameworks governing antimicrobial use. However, certain areas of concern emerged, including hesitancy towards embracing educational programs on antimicrobial stewardship. Furthermore, observed practices varied considerably. While some breeders demonstrated responsible practices, such as seeking veterinary advice and adhering to professional guidance, others engaged in risky behaviors, including self-treatment of animals, purchasing antimicrobials without prescriptions, and neglecting to read usage and expiration instructions. Critically, a widespread lack of understanding regarding appropriate withdrawal periods for meat, milk, and eggs was evident. In conclusion, these findings highlight a critical need for targeted interventions, including educational programs and stricter enforcement of regulations, to promote prudent antimicrobial use in animal production and mitigate the escalating threat of antimicrobial resistance. This study contributes valuable insights for developing effective strategies to safeguard both animal and human health.

Recommendations

Based on the study findings, the following recommendations are proposed to promote prudent antimicrobial use in animal production:

1. Enhancing Knowledge and Awareness: Multifaceted educational interventions are crucial to improve breeders' understanding of antimicrobial use. These interventions should encompass:
    - Targeted Educational Campaigns: Implement intensive and diverse awareness campaigns utilizing various channels, including workshops, seminars, television and radio programs, publications, and social media platforms. These campaigns should focus on clarifying misconceptions and disseminating accurate information regarding:
    - Antimicrobial withdrawal periods for different animal species and products (meat, milk, and eggs).
    - The risks associated with excessive and inappropriate antimicrobial use, including its impact on human and animal health and the development of antimicrobial resistance.
    - The critical importance of consulting a veterinarian before administering any antimicrobial.
    - Development of Accessible Educational Materials: Create simplified educational resources in clear, accessible language, such as instructional booklets, infographics, and videos, for distribution to animal breeders. These materials should be developed under the supervision of the Ministry of Animal Resources in collaboration with relevant stakeholders, including veterinary associations and agricultural extension services.

2. Promoting Positive Attitudes and Behavioral Change: Strategies to foster positive attitudes and encourage the adoption of best practices should include:
    - Interactive Educational Programs: Organize participatory educational programs that facilitate knowledge sharing, open discussions, and experience exchange among animal breeders. These programs should aim to address concerns, dispel misconceptions, and promote behavioral change towards responsible antimicrobial use.
    - Peer-to-Peer Learning and Best Practice Dissemination: Showcase successful examples of breeders who have implemented effective antimicrobial stewardship practices to encourage peer learning and adoption of best practices.
    - Stakeholder Engagement and Community Dialogue: Establish a platform for open dialogue and collaboration among animal breeders, veterinarians, government agencies, non-governmental organizations, and other relevant stakeholders to discuss challenges, share experiences, and develop collaborative solutions.
3. Strengthening Regulatory Frameworks and Enforcement: To ensure compliance and promote responsible practices, the following measures are recommended:
    - Enhanced Veterinary Oversight: Strengthen field veterinary control over antimicrobial use on farms to ensure adherence to prescriptions, withdrawal periods, and other relevant regulations.
    - Stricter Control of Antimicrobial Distribution: Implement stricter regulations on the sale and distribution of antimicrobials, restricting access to authorized veterinary prescriptions only.
    - Improved Access to Veterinary Services: Enhance the availability and affordability of quality veterinary services, particularly in remote areas, to encourage regular consultation with veterinarians.
    - Support for Research and Development: Invest in scientific research focused on developing alternatives to antimicrobials, such as vaccines and improved biosecurity measures, and promoting preventive strategies to minimize antimicrobial use.
    - Implementation of Antimicrobial Use Monitoring Systems: Establish a comprehensive tracking system to monitor antimicrobial usage on farms, enabling data collection, analysis, and targeted interventions to reduce overuse and promote responsible use practices.

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