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Research Article

Comparative Study on the Use of Artificial Insemination in Sows in Three Production Units in the Region of Tlachichuca Puebla, México

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Abstract

The main objective of this study was to make a comparison of the use of artificial insemination in sows from three production units belonging to the Tlachichuca-Puebla region, Mexico. These pork production units belonged to the communities of José María Morelos, San Francisco Independencia and Tlachichuca, Puebla respectively. 20 sows were used, 15 of which were primal and 5 multiparous, which were inseminated over a period of 10 months. 20 doses of semen were acquired from the Coyametl Genetic Transfer Center, located in the City of Acatzingo, Puebla. The information obtained from the project was concentrated in the different stages of the study, and stored in an Excel file; the information was processed through the SPSS 10 package for Windows, applying descriptive statistics. 75% of Primal or Nulliparous sows were found which were artificially inseminated and 25% corresponded to Multiparous; 7% of the producers expressed no interest in planning but rather a greater number of kilos when selling, 15% responded interest in the number of offspring and fewer deaths at birth with better feeding of the bellies before and after the births, 78% mentioned the importance of planning a procedure to improve their productivity and reproductive life in their pork production units (PPUs). Regarding litter size, results were obtained through AI in the sows of the 3 UPPs (José María Morelos, San Francisco Independencia and Tlachichuca), a total of piglets in the primals of 163 of the 15 inseminated sows, with an average of 10.8 piglets/sow; In the case of multiparous sows, there were 58 piglets in total with an average of 11.6 piglets/sow. In conclusion, comparative studies are useful for analysis in pork production units, since they are pillars in decision making; as it was, in the reproductive indicators where AI was applied, giving objectivity and greater certainty as was the case in the three communities of the Tlachichuca region, Puebla, Mexico.

Keywords

Comparative, Artificial Insemination, Sows, Primals, Multiparous, Production

1. Introduction

Pork has very important nutritional properties and is a powerful source of income for the countries that produce it. The development and use of AI in sows has made great progress throughout history [1, 2]. Starting in Russia at the beginning of the 20th century, it spread to other countries, as established [3]. Artificial insemination (AI) in sows allows us to provide genetic material of excellent quality to the farm or production unit, to optimize productive and reproductive parameters; Their contribution has achieved maximum use of the genetic potential of high-value breeders and has been an essential tool in the prevention and control of swine diseases [1, 4].

With the acquisition of semen it is possible to implement genetic diversity in pig farms to improve crossing systems [5]. The growing demand for pork forces us to develop each of the factors of pork production, better and innovative reproductive tools in production units; such as the use of artificial insemination in sows with a meat profile, consequently greater profitability and sustainability in pig production [6]. Such is the case of Mexico, where this reproductive technology has been used in technical farms; but, where it is required to use it with greater impact and frequency in community production units [7].

Currently, the use of Artificial Insemination (AI) in breeding sows has had a great impact on improving fertility, genetics, farm work and herd health [8]. It is a technique applied to sows with greater acceptance and low cost, due to the universality of the technique; where the costs for its management and use have decreased when it is used on the farms of small, medium and large producers in the world and in our country [5]. Therefore, it is relevant to make important comparisons of some reproductive indicators of community-type pig production units [9, 10]. With the sole objective of comparatively studying the use of artificial insemination in sows in three production units in the Tlachichuca Puebla region, Mexico.

2. Materials and Methods

2.1. Study Location

The municipality of Tlachichuca is located in the central-eastern part of the state of Puebla (Figure 1), its geographical coordinates are the parallels 19 °01' 36" and 19 °19' 54" of north latitude and the meridians 97 °10' 24" Y 97 °30' 18" west longitude. It limits to the north with Guadalupe Victoria, to the south with Chalchicomula and Atzitzintla, to the east with the state of Veracruz, Quimixtlán and Chilchotla and to the west with Aljojuca and San Nicolás Buenos Aires. It has an area of 422.17 square kilometers, which places it in 12th place with respect to the other municipalities in the State.
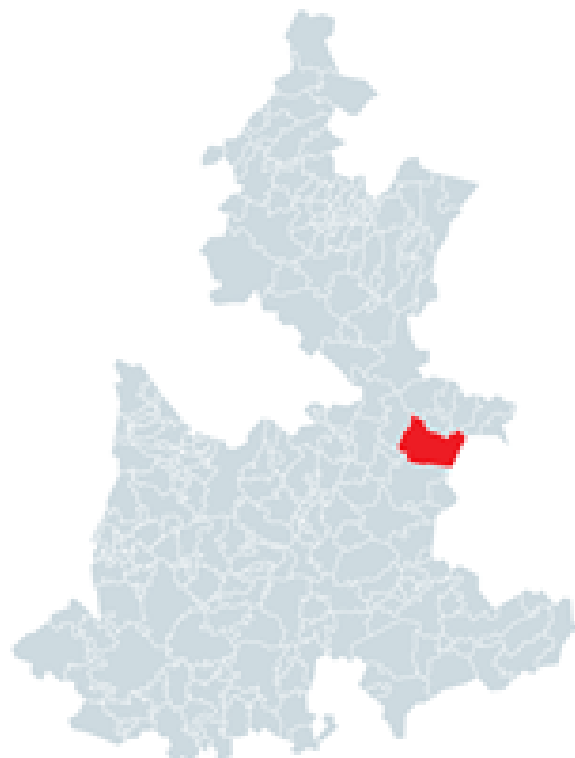

Figure 1. *Location of the municipality of Tlachichuca in the state of Puebla.*

The small hills located in the plain and the lower slopes of the "Derrumbadas" hill have *rosetophilous* desert scrub, generally of samandoca palm. The areas corresponding to the plains of San Juan and San Andrés are dedicated to seasonal agriculture (Figure 2), which little by little is extending towards the mountains, at the expense of the forests.

Figure 2. *Area of the great plains of the municipality of Tlachichuca Puebla.*

In fauna in the municipality there are the following species: coyotes, rabbits, armadillos, squirrels, vipers, snakes and birds of different species. Altitude of the municipality of Tlachichuca 2,603 meters above sea level, it has an oceanic climate. Rain falls every month of the year.

The average annual temperature in Tlachichuca is 22℃ (degrees celsius) and the average annual precipitation is 762 mm (millimeters). It does not rain for 102 days a year; the average humidity is 77% [11].

2.2. Study Methodology

20 sows were used, of which 15 are primal and 5 multiparous, which were inseminated over a period of 10 months, where they were manipulated before AI; The age of the females considered in the study was confirmed, they were healthy and had not had problems with placenta retention and infectious vaginal discharge, normal cyclicity of estrus. Semen fertility was evaluated in the boars used and a nutritional diet was considered for the females that were cared for in this study.

Classic postcervical AI probes, catheters, antibiotics, toilet paper and wipes, clean pen to immobilize the sow (space), field notebook for notes, black ink pen, and liquid nitrogen thermos with a capacity of 20 liters were required. to protect the semen straws used in AI. The semen was acquired per dose (20) from the Coyametl Genetic Transfer Center, located in the City of Acatzingo, Puebla, Mexico. Finally, three pig production units from the municipality of Tlachichuca, Puebla were used.

2.3. Monitoring Protocol in the Sows Inseminated in the Study

1. Immobilization of the sow in the pen used during the insemination phase.
2. Clean the vulvas with drinking water and dry with toilet paper or sanitary towel.
3. Sows with vaginal discharge were treated with a non-spermicidal local antibiotic before the introduction of the AI probe.
4. Introduction of the lubricated probe (post-cervical) avoiding the urinary canal, placing it from the bottom to the top, pulling outward from the vulva.

5. Finally, post-cervical AI was performed, holding the sow's vulva together with the probe; where the vulva was slightly stretched outward to lengthen the cervix and facilitate the passage of the rings to deposit the semen.

2.4. Statistical Processing and Duration of the Study

All the information obtained from the 3 pork production units in the region under study was concentrated, the database was stored in an Excel file; where, variables such as: a) percentages of primals and multiparous in study, b) percentage of sick sows, viable offspring at birth, c) management and care of the pig production units (UPP), d) Qualification of the producers of the 3 PPUs, e) Pregnancy percentage of sows inseminated by AI.

The information was processed through the SPSS 10 package for Windows, to obtain relative frequencies and standard deviation of the variables under study. The duration of the study was January – October 2023.

2.5. Mathematical Formulas Applied to Variables in the Study

LVP = Σ Weight of live piglets
Number of piglets
Live weight of the litter (LVP)
BWPP = Σ live piglet weights
Number of live piglets
BWPP = Σ live piglet weights at birth
PSMP = N^0 dead animals x100
Total animals
Percentage of stillborn and mummified piglets (PSMP)

3. Results

Efficient pig production requires a highly productive herd of sows; It is important to analyze the actions of the PPUs that have been considered in this AI study; Therefore, Table 1 shows information found during the study of the three PPUs in the municipality of Tlachichuca Puebla.

Table 1. Information found and used in the three UPPs of the different communities studied in the AI of the Municipality of Tlachichuca, Puebla.

UPPs considered in AI in sows in the region studied			
Indicators	José María Morelos Puebla	San Francisco Independencia Puebla	Tlachichuca Puebla
Inseminated Sows	7	7	6

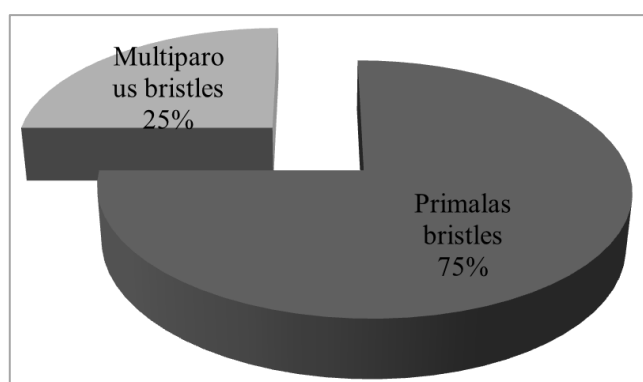| UPPs considered in AI in sows in the region studied			
Indicators	**Jos éMar á Morelos Puebla**	**San Francisco Inde-pendencia Puebla**	**Tlachichuca Puebla**
Primal or Nulliparous Sows	4	6	5
Multiparous Sows	3	1	1
Sows that Presented Any Reproductive Health Alteration	0	1	0
Average Body Condition of Sows (0 to 5)	4	4	5

Figure 3. Percentages of sows artificially inseminated with respect to their number of births.

75% of the sows artificially inseminated through the post-cervical procedure carried out a production activity of gilts (Figure 3), and therefore their reproductive and productive performance; it would be supported by a cornerstone for its commercial profitability. However, it is essential to consider some aspects such as: the annual number and duration of live piglets after birth and weaning.

In relation to the statistical analysis applied to the reproductive health indicators (Table 2), of the number of sows inseminated at the first service (primary) with respect to the number of multiparous sows, a statistical mean ($\dot{x}$) was found for primals of 5.0 and in the case of multiparous women of 1.6; observing a numbered statistical difference in the standard deviation of both studied indicators of the 3 Pork Production Units (PPUS).

Table 2. Means and standard deviations (SD) regarding the indicators considered in the AI in the PPUs of the Tlachichuca region, Puebla.

Indicators	**N**	**Minimum**	**Maximum**	**Medium ($\dot{x}$)**	**±SD**
Inseminated Sows	3	6.00	7.0	6.6	0.577
Primal Bristles	3	4.00	6.0	5.0	1.00
Multiparous Sows	3	1.00	2.0	1.6	0.57
Sick Sows	3	0.00	1.0	0.3	0.57
Corporal Condition	3	4.00	5.0	4.3	0.57

N= Number of PPUs considered in the study

It is important to mention that alterations or diseases regarding artificially inseminated sows must be considered in any breeding program; by natural or AI mating, in this study the sick sow had vaginal discharge and was in heat; however, the infection did not allow her to become pregnant at the beginning of natural mating. After diagnosis, treatment with antibiotics (beta-lactams) and hormones (prostaglandin f2α) was initiated. As a result, she was in heat 11 days after treatment, achieving pregnancy through AI.

Regarding pig production in the region of Tlachichuca, Puebla, producers are currently looking for a product derived from the reproductive activity of their sows; with better levels, in terms of number of offspring and zero mortality at birth, but better sustainable aspects in the quality of the meat at slaughter. Through a survey of pig producers in the region of Tlachichuca, Puebla (communities under study) and questioning them about the use of protocols that allow the planning and proper functioning of their bellies; the following was

found, 7% expressed no interest in planning, but rather in having a greater number of kilos when selling.

15% responded interest in the number of offspring, and fewer deaths at birth with better feeding of the uteruses before and after births; finally, 78% indicated that it is important to manage a project or procedure in a planned manner to improve their productivity and reproductive life in their UPP.

Figure 4 determines an important qualification of the producer with respect to its reproductive and sanitary management; where, it gives an estimated appreciation in their productive units of the 3 communities studied, on a scale from 0 to 10. In relation to the pregnancy rate, table 3 establishes the total number of artificially inseminated sows in the communities of the Tlachichuca region, Puebla.
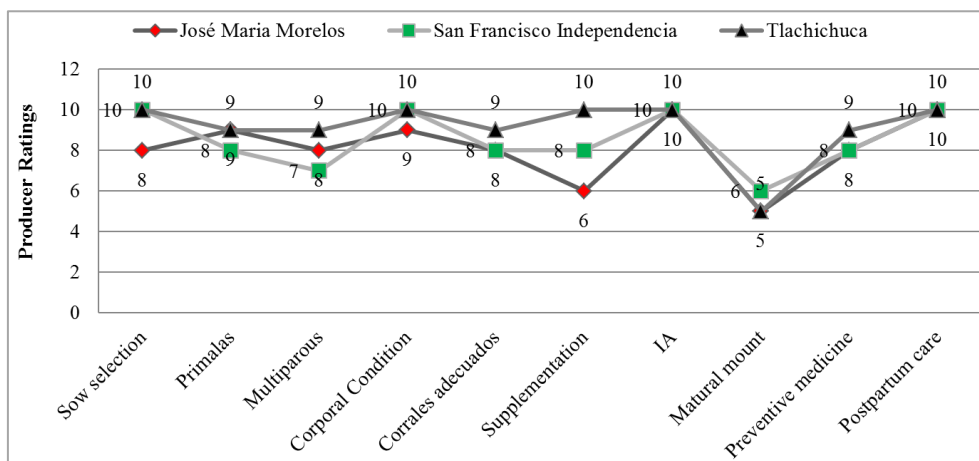

Figure 4. Comparative ratings given by the producers of the three communities studied in the municipal region of Tlachichuca, Puebla, Mexico.

Table 3. Pregnancy rate in the total number of artificially inseminated sows in the study region.

	μ	σx	M	Mode	DE	σ	Minim.	Maximum.
N	3	3	3	3	3	3	3	3
Comunity	2.0	.57	2.0	1.0[a]	1.0	1.0	1.0	3.0
Sow selection	9.33	.666	10	10	1.15	1.33	8	10
Primalas	8.66	.33	9	9	.577	.333	8	9
Multiparous	8	.577	8	7[a]	1	1	7	9
Bodily corporal	9.66	.333	10	10	.577	.333	9	10
Suitable pens	8.33	.333	8	8	.577	.333	8	9
Supplementation	8	1.15	8	6	2	4	6	10
AI	10	.00	0	10	.00	.00	10	10
Natural riding	5.33	.333	5	5[a]	.577	.333	5	6
Preventive medicine	8.3	.333	8	8	.577	.333	8	9
Postpartum Care	10	.00	10	10	.00	.00	10	10

Table 3 determines a lower score for the community of San José Maria Morelos, and in the statistical mode for multiparous the result was 7; where the natural mount was 5, statistically a value that would be given in the case of using it as a last resort when not having AI. In relation to the pregnancy rate, figure 5 shows the total number of artificially inseminated sows in the communities of the Tlachichuca region, Puebla.

Regarding litter size, results were obtained in 11.6 piglets/sow, as well as other aspects of management in the three

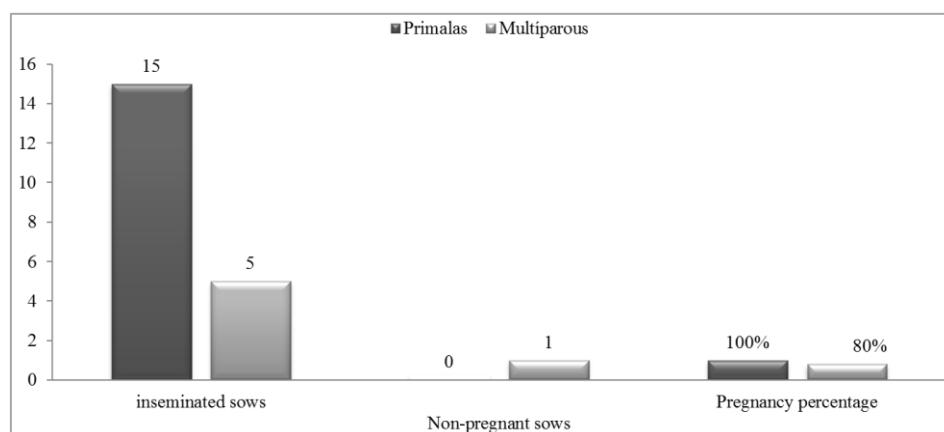pig production units considered in the study (Table 4).

Figure 5. Percentage of artificially pregnant sows.

Table 4. Descriptive statistics regarding the total number of piglets with their averages per litter and their weights at birth and weaning of the three communities considered in the region of Tlachichuca, Puebla.

	N	Range	Minimum	Máximum	Σ	Mean	ED	Variance
PPUs	3	2.00	1.00	3.00	6.00	2.000	1.000	1.000
Total piglets in Primalas	3	13.00	50.00	63.00	163.00	54.333	7.505	56.333
Total piglets in Multiparas	3	26.00	10.00	36.00	58.00	19.333	14.468	209.333
Average number of pigletsper litter	3	13.00	30.00	43.00	110.50	36.833	6.525	42.583
Average piglet weight per litter	3	0.15	0.85	1.00	2.80	0.933	7.638	5.833
Average piglet weaning weight per litter	3	0.40	5.60	6.00	17.40	5.800	0.2000	4.000

4. Discussion

Artificial insemination is a biotechnological reproductive tool that is applied in animal production in order to increase productive efficiency, achieve greater genetic progress and increase reproductive performance [12].

Table 1 projects some indicators for efficient and profitable production, such as the case of sows that are inseminated and establish their first farrowing; however, this can be correlated with subsequent performance, where the ability of the sow to remain in the production unit in the case of reproduction can be high and its reproductive life significant [13].

75% of the sows artificially inseminated through the post-cervical procedure performed an activity of producing young sows; and therefore, its reproductive and productive performance would be based on a cornerstone for its commercial profitability. However, it is essential to. It is expected that the mature reproductive production unit should be more prolific and therefore improve productivity [14]. In this way,

it is relevant to consider sows with short longevity as an advantage for reproduction naturally or artificially; however, we must not rule out these parameters; they are affected by environmental factors such as the farm, year, season, calving number and their interactions [15].

It is important to mention that alterations with respect to sows to be inseminated must be considered in any breeding program; whether natural or AI mating, in this case the sick sow showed vaginal discharge and was in heat; however, the infection did not allow her to become pregnant at the beginning with natural mating. This sow was clinically assisted with beta-lactams and prostaglandin f2α, which allowed her to be in heat 11 days after clinical treatment and achieve pregnancy through Artificial Insemination. similar treatment establishes [16] when performing a uterine lavage, by introducing an artificial insemination catheter, it was possible to bring an antibiotic such as oxytetracycline to the focus of the infection, and with the use of a prostaglandin f2 alfa; elevo, uterine contractions and the width of the cervix, which facilitated washing and increased the efficiency of the treatment to restore the reproductive activity of heat in the

treated sows. One of the basic pillars in pig production is the pregnant sow, which is why; it is essential to monitor and clinically assist reproductive problems due to infections, hormonal and nutritional problems for effective success in the production unit [17].

Figure 4 indicates the most important aspects that the producer of the three communities under study in the region of Tlachichuca, Puebla, considered significant in the use of planned and well-functioning management during times of reproduction of their sows. On a rating scale from 0 to 10. In a study carried out by Peña, D establishes aspects in reproductive management such as: age and weight of the sow, genetics, nutrition, direct mating, facilities and sanitary conditions [18]; however, despite the similarity in the indicators in both studies, the latter does not indicate percentages or what rating scale it followed, although it mentions that planned reproductive management is successful in the pig production unit.

It is important to point out some characteristics regarding the management of plans in the reproductive activity of the sow; in relation to what was found in this study, nulliparous females (primala females) mating should be carried out when the animals have reached a sufficient live weight and at an age of no less than 7 or 8 months of age. However, the age at first heat, the weight and the GDP (Daily Weight Gain) in the replacement sows influence their productive life on the farm, and therefore their importance of management as future breeders and not as sows. Get fat [19].

To achieve good results it is advisable to cover no earlier than the 2nd heat. Adult females (who have already been mothers) usually show a new heat approximately between 3 and 5 days after weaning; however, it is important to continue the trajectory of multiparous mothers with good births in their productive lives [20]. It is better to consider not using them in this way as found in this study; since it can reduce the reproductive and productive potential, due to aspects of irregular cyclicity, weight of the offspring at birth, mortality of offspring and low weights to reach weaning in a timely manner, as well as the producer's preference to use them in management, planned reproductive program with low grades in their records [21].

In a similar study carried out by [22] where he applied AI in sows of 2nd, 3rd, 4th and 5th farrowing from a total of 16 experimental units, he found a higher percentage of pregnancy with 93.7% without mentioning how many sows were exposed to the AI; furthermore, it does not establish whether there was any cause or factor present that affected the pregnancy percentage, as was the case studied in the three pork production units in the Tlachichuca-Puebla region, Mexico.

In a study carried out by Hernández *et al.* mentioned by Vanina *et al.* through postcervical AI, they achieved on average a farrowing rate of 84% and a litter size of 13.9 total piglets born [23, 12]. However, they do not mention in which reproductive phase (nulliparous or multiparous) the inseminated sows were. This is different from what was found in this study, where postcervical AI was applied in both reproductive phases (Nulliparous and Multiparous), obtaining a 90% farrowing rate and a litter size of 11.2 total piglets born.

Regarding weaning weight, an average of 5.8 kg/piglet was found in the 3 pig production units at 35 days, a conservative weaning program; since producers seek a better survival option by not weaning early. However, [24] establishes that weaning is variable; since it can vary, according to weight and age, influenced by several aspects such as: type of mother's diet, preventive medicine programs, meat quality, market and even the management of the pig in green, substance-free and biological environments the Piara. Traditional or technical management activities regarding the weight of the weaned piglet, [25] cited by Garcia ensure that the ideal weight at weaning is between 6.0 and 7.2 kg. [26], which are very similar to the averages of the weights of piglets in traditional and technical cages.

5. Conclusions

Comparative studies are very important analysis tools for decision making in pork production units; managing reproductive indicators, they provide objectivity and greater certainty, as was the case of AI applied in the communities of the Tlachichuca region, Puebla, Mexico.

The use of AI in the sows of the PPUs of the communities of José María Morelos, San Francisco Independencia and Tlachichuca, Puebla during their reproductive cycle, is a highly favorable technique to improve productive indicators such as: lower percentage of mortality, size of the litter, better birth weight, important weaning weight, better animal health and well-being (mothers and offspring).

The participation of pig producers in the study region was essential since it correlated productive aspects of the pig unit, but it was important to point out not using natural mating; due to the fact that the weights and number of litters of the piglets are lower than those of the use of AI in their sows.

Abbreviations

BUAP: Benemerita Autonomous University of Puebla
SPSS: Statistical Package for Social Sciences
AI: Artificial Insemination
Kg: Kilogram

Author Contributions

Genaro Vázquez Reyes: Conceptualization, Funding acquisition, Investigation, Project administration

Fernando Utrera Quintana: Conceptualization, Resources, Data curation, Software, Formal Analysis, Supervision, Investigation

Juan Cruz Avina: Conceptualization, Supervision, Validation, Investigation, Visualization

Claudia Morales Evangelista: Conceptualization, Super-

vision, Validation, Investigation, Visualization

Jorge Hernández Hernández: Conceptualization, Resources, Data curation, Formal Analysis, Supervision, Investigation, Visualization, Methodology, Project administration

Conflicts of Interest

The authors declare no conflicts of interest.

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