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Use of molasses or soybean oil with two levels of vitamin C in diets for of *Cavia porcellus*

Uso de melaza o aceite de soya con dos niveles de vitamina C en dietas para *Cavia porcellus*

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ABSTRACT

Special pet feeds are necessary to increase animal welfare and maintain good health. The objective of this investigation was to know the effect of molasses or soybean oil as an energy source with two levels of vitamin C evaluated in maintenance diets. 24 females randomly distributed in four treatments with six repetitions each were used, they received a diet with 3.0 Kcal of digestible energy with soybean or molasses oil and 100 or 300 mg of ascorbic acid per kg of food. Weight gain (WG), feed consumption (FC), capillary permanence, anagen and mortality for 28 days were evaluated. The data obtained was analysed with a completely randomized design with a 2 x 2 factorial arrangement. We did not observe an interaction but there was an effect on food consumption when using molasses with 100 mg of Vitamin C in the first week, there was no effect of the treatments on the capillary permanence or mortality. Adding soybean or molasses oil as a concentrated source of energy combined with 100 or 300 mg of vitamin C per kg of food does not affect body weight, mortality and hair permanence, but it modifies food consumption at the guinea pig.

Keywords: Anagen in cuy, feedstuff for cuy, pellet for cuy, guinea pig.

RESUMEN

Los alimentos especiales para las mascotas son necesarios para aumentar su bienestar animal y mantener su buen estado de salud. El objetivo de la investigación fue conocer el efecto de la melaza o aceite de soya como fuente de energía combinada con dos niveles de vitamina C en dietas para mantenimiento en cuyes. Se usaron 24 hembras distribuidas al azar en cuatro tratamientos con seis repeticiones cada uno; los animales recibieron una dieta con 3.0 Kcal de energía digestible con aceite de soya o melaza y 100 o 300 mg de ácido ascórbico por kg de alimento. Se evaluó la ganancia de peso (GP), el consumo de alimento (CA), la permanencia capilar en anagén y la mortalidad durante 28 días. Los datos obtenidos se analizaron con un diseño completamente al azar con arreglo factorial 2 x 2. En los resultados no observamos interacción, pero hubo efecto en consumo de alimento al usar melaza con 100 mg de Vitamina C en la primera semana, no hubo efecto de los tratamientos sobre la permanencia capilar o mortalidad. Adicionar aceite de soya o melaza como fuente concentrada de energía combinada con 100 o 300 mg de vitamina C por kg de alimento no afecta el peso corporal, la mortalidad y permanencia capilar pero modifica el consumo del alimento en los cuyes.

Palabras clave: Anagén en cuyes, alimento para cuyo, pellet para cuyo, guinea pig.

INTRODUCTION

Cavia porcellus is a rodent mammal, herbivorous with twilight habits, native to the Andean zone, made up of Bolivia, Ecuador, Colombia and Peru; where it is part of the local gastronomy (Sánchez *et al*., 2012). In Mexico it adopts the common name of *cuye* or *cuyo*; it reproduces to be commercialized as a companion animal, because it adapts easily to confined spaces, but its food requirements are complex (Guevara *et al*., 2014). Guinea pigs have a glandular stomach, which degrades simple carbohydrates by enzymatic action, but is a post-gastric fermenter, due to its blind degradation of complex carbohydrates through bacterial fermentation (Meza *et al.,* 2014). Therefore, your diet must contain adequate amounts of fiber; in addition to vitamin C that your body cannot synthesize due to the lack of L-gulonolactone oxidase (Quintana *et al*, 2013).

Guinea pigs are generally fed fresh vegetables, such as cabbage, chili peppers, lettuce or carrots; sometimes they feed on hay, pasture, fresh or dehydrated alfalfa (Reséndiz and Hernández, 2008). Sometimes they feed it with diets prepared for rabbits, pigs or with mixed diets (Reyes *et al.,* 2018). But their poor diet can cause liver problems, kidney problems or conditions associated with chronic nutritional deficiencies. Therefore, balanced foods for their species meet the specific nutritional requirements capable of improving their life and the general condition of their species (León *et al.,* 2016).

The body, by receiving the appropriate nutrients, can carry out efficient metabolic maintenance processes, but if it has nutritional deficiencies, they can manifest themselves in different ways. In guinea pigs, nutritional deficiencies can be identified in their hair, measuring the stage of active growth known as anagen, due to the independence of the active follicle cycle and its duration (Jackson and Ebling, 1971). Its body decreases collagen production if your intake of ascorbic acid drops for two to three weeks, because it synthesizes the coenzyme for the sub-hydroxylated collagen precursor (Harwood *et al*., 1973; Grosso *et al*., 2013). By receiving a diet deficient in vitamins caused by ingredients in the diet, its hair can modify its active growth, indicating its state of health.

When balancing the food, protein, energy, minerals and vitamins are mixed in a balanced way (Marsanasco *et al*., 2011). The variety of balanced foods for guinea pigs in Mexico is limited, both in presentations and possibly in their nutritional requirements. Developing a maintenance feed is suitable for the species, if it is pelleted, less is wasted, it is of high density, it does not allow the selectivity of the ingredients for the tastes of the animals Reséndiz and Hernández, 2008; Tarrillo *et al*., 2020).

Adding molasses as an energy ingredient in commercial guinea pig feed is common, due to its low cost. It is also an energetic that provides a characteristic sweet smell to improve its palatability. However, its characteristics may interact with the added Vitamin C, making it difficult to mix and distribute micro ingredients in the final product (Bonilla and Usca,

2015). An alternative as an energy source can be crude soybean oil, which in addition to providing energy to the diet, contains linoleic acid and facilitates food preparation, but at higher costs compared to molasses.

Therefore, the objective of the research was to know the effect of molasses or soybean oil as energy sources, combined with two levels of vitamin C 100 mg/Kg and 300 mg/Kg of food in diets for the maintenance of *Cavia porcellus* .

MATERIAL AND METHODS

Experiment Location

The research was carried out at the zootechnical post of the University of Guanajuato, Campus Irapuato - Salamanca; located at 1,730 meters above sea level, in a temperate climate with an average temperature of 32 °C and annual rainfall of 692 mm. The animals were cared for following the recommendations of NOM-062-ZOO-1999 and the experiment was authorized by the Agricultural-Livestock Research Committee of Laboratory AG S.A. of C.V. (OFAG01-2019).

Animals and facilities

24 females housed in individual 34 x 54 cm cubicles were used, with automatic nipple drinkers, feeders attached to the base for 60 g of feed, 5 cm thick sawdust beds and a 12 cm wide by 30 cm PVC tube. cm long to avoid your stress. The guinea pigs were randomly distributed in four treatments, each animal was identified, weighed and its food consumption was determined weekly for four occasions. Every day the health status of the animals was monitored looking for signs of vitamin C deficiency. The thermal conditions of the premises were controlled at 25 ± 2 ºC with electric heaters (Dayton®).

Preparation of the diet and pellets

The diet was made from corn and soybean paste, the energy was set at 3.00 Mcal with molasses or crude soybean oil and vitamin C at 100 and 300 mg/Kg of food suggested by the 1995 NRC (table 1). To manufacture the pellet, a pelletizing machine with an 8.4 mm inlet and 8.0 mm outlet bore, a 120 mm long and 24 mm thick disc was used. The die of the machine was of mechanical compression with a 3.5 mm wide and 3.0 mm deep groove, 3 Hp electric motor at 127 volts and transmission of 100 kg per hour (Model: PLM0021, NS: PLED22062016).

Table 1. Ingredients of the diet per treatment (%).

Ingredients	T1	T2	T3	T4
Corn	51.55	51.55	51.55	51.55
Alfalfa	5.00	5.00	5.00	5.00
Soybean paste	21.01	21.01	21.01	21.01
Molasses	0.00	3.00	0.00	3.00
Soybean oil	2.25	0.00	2.25	0.00
Rice polishing	13.90	13.90	13.90	13.90
$CaCO^3$	2.00	2.00	2.00	2.00
Orthophosphate	2.59	2.59	2.57	2.57
Salt	0.30	0.30	0.30	0.30
Vitaminic Premix[1]	0.10	0.10	0.10	0.10
Mineral premix[2]	0.10	0.10	0.10	0.10
C Vitamin	0.10	0.10	0.30	0.30
L-lysine HCL	0.06	0.06	0.06	0.06
DL-Methionine	0.36	0.36	0.36	0.36
Inert material	0.67	0.00	0.33	0.00
Ascorbic acid	0.01	0.01	0.03	0.03
Calculated analysis				
Disgestible energy (Mcal Kg^{-1})	3.00	3.00	3.00	3.00
Crude protein	17.12	17.12	17.12	17.12
Calcium	1.28	1.28	1.28	1.28
Available phosphorus	0.62	0.62	0.62	0.62
Fiber	3.00	3.00	3.00	3.00

[1]Amount in mg per kg of food: vitamin A, 10,000 IU; vitamin D3, 2,500 IU; vitamin K3, 2 mg; thiamine, 2 mg; riboflavin, 7 mg; pantothenic acid, 10 mg; pyridoxine, 4 mg; folic acid, 1 mg; Vitamin B12, 0.015 mg; and biotin 0.010 mg (Vipresa), Tepatitlán de Morelos, Mexico.
[2]Amount in mg per kg of food: Se, 0.20; I, 0.30; Cu, 7; Faith, 65; Zn, 75; Mn, 65; and Co, 0.4 (Vipresa), Tepatitlán de Morelos, Mexico.
T1 = Soybean oil with 100 mg/kg of Vitamin C per kg of feed.
T2 = Molasses with 100 mg/kg of Vitamin C per kg of feed.
T3 = Soybean oil with 300 mg/kg of Vitamin C per kg of feed.
T4 = Molasses with 300 mg/kg of Vitamin C per kg of feed.

Capillary permanence

To know the changes in the health status of the guinea pigs, a sample of 100 hairs was taken at the beginning and end of the experiment. The sixth and eighth dorsal vertebrae were used as sampling zones, a straw and a hemostat were used to exert pressure on the base of the hair and extract it in its entirety. The samples were placed on a slide, they were hydrated, and a coverslip was placed on them to know their growth status in anagen (figure 1).

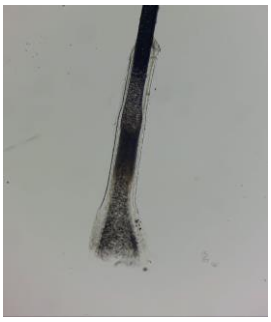

Figure 1. Guinea pig hair base extracted from the skin in Anagen at 10x

Statistical analysis

Weight gain and feed intake data were analyzed using a completely randomized experimental design, with a 2 x 2 factorial arrangement; where factor A was molasses or soybean oil and factor B = 100 or 300 mg of ascorbic acid per kg of feed. Capillary permanence was evaluated in anagen, compared to the Wilcoxon test for paired samples, using the PROC UNIVARIATE procedure. The data were run with the statistical program SAS (SAS, 2010), the model used was:

$$Y_{ijk} = \mu + A_i + B_j + AB_{ij} + e_{ijk}$$

Where:
Y_{ijk} = Weight gain, feed intake
μ = General mean
A_i = Molasses or Soybean Oil
B_j = Ascorbic acid level
AB_{ij} = Interaction between molasses, soybean oil and ascorbic acid level
e_{ijk} = Experimental error

RESULTS

There was no effect of the concentrated source of energy and level of vitamin C on the body weight of the animals during the four weeks (table 2). The addition of molasses with 100 mg of vitamin C increased (P≤0.05) the feed consumption the first week (table 3), but in the third week the consumption of feed with soybean oil and 100 mg of vitamin C (P ≤0.05). In the first and second week, the guinea pigs consumed less food (P≤0.05). During the experiment there was no mortality and the capillary permanence in its anagen state did not show differences at the end of the treatments (data not shown).

Table 2. Body weight of guinea pigs (g) fed with diets added with soybean oil or molasses and 100 or 300 mg of C vitamin per kg of feed

Source of energy	C vitamin (mg/kg)	Week			
		1	2	3	4
Soybean oil	100	703±152	714±13	737±16	768±155
	300	603±142	622±19	648±118	665±102
Molasses	100	591±130	621±123	649±124	697±90
	300	589±143	611±134	632±135	656±143
		Pr > F			
A		0.2941	0.3558	0.3572	0.4856
B		0.3908	0.3664	0.3496	0.2168
A*B		0.4093	0.4661	0.5224	0.5845

DISCUSSION

The body weight of guinea pigs is related to their race, sex, zootechnical purpose and type of food received. The NRC (1995) and Morales *et al*. (2011) evaluated two energy levels: 2.8 and 3.0 Mcal per kg of food in isoprotein diets, obtaining greater weight in animals by ingesting more energy. Guinea pigs do not receive an adequate diet for their physiological state, they weigh less; therefore, by eating a food suitable for your body mass, it will increase, as happened in the study, due to the effect of your previous diet. Therefore, the guinea pigs did not gain weight, they only adapted to a balanced diet; their weight gain per day was 2.5 g, an adequate gain for a maintenance diet, compared to fattening animals that gain 30 g of weight per day with adequate food.

Table 3. Feed consumption per day of guinea pigs fed diets added with soybean oil or molasses and 100 or 300 mg of C vitamin per kg of fed

Source of energy	Vitamin (mg/kg)	Week			
		1	2	3	4
Soybean oil	100	25 ±2.4by	30±5.4y	34±7.0w	32±3.2wx
	300	23±3.2b	29±8.2	33±6.5	32±4.7
Molasses	100	29±4.2a	30±8.2	33±6.4	32±2.0
	300	20±34b	27.7±4.7	28±9.5	28±6.5
		Pr > F			
A		0.6848	0.7999	0.3348	0.6812
B		0.0020	0.5107	0.3731	0.1217
A*B		0.1018	0.6994	0.6756	0.8999

[a – b] Different letters in the columns indicate statistical difference (P≤0.05)
[w, x, y] Different letters in the rows Indicate statistical difference (P≤0.05)

Airahuacho and Vergara (2017) report that guinea pigs used as pets should ingest less than 2.9 Mcal of ED to limit their weight gain. Camino and Hidalgo (2014) evaluated guinea pigs in fattening with different genotypes, showing their efficiency, increasing 15 g per day.

In the present study, the diet was balanced to comply only with the maintenance of the animals, therefore there were only minimal weight gains; what is emerging as a suitable food for maintenance in type B guinea pigs; animals with little muscular development, elongated triangular head, shallow body depth, ears with different sizes and nervous animals (Chauca, 1997).

Food consumption is a base measure to evaluate a diet and is evidenced by the preferences of the animals. Guevara *et al*. (2013) used fish oil and their guinea pigs ate 41.85 to 43.71 g of food per day. In this research, the daily food consumption was 28.37 and 29.75 g with molasses and soybean oil, data that exceed those reported by Quintana *et al*. (2013) and similar to those of Guevara *et al*. (2013) who investigated that using shrub plants in the diet obtained intakes of 24.22 to 29.50 g/day. Guinea pigs can

consume up to 56.96 g of food per day, as reported by Morales *et al*. (2011); but ingredients suitable for guinea pigs should be used during the preparation of the diet.

The difference in food consumption can vary, due to the concentrated source of energy used in the experiment, its extra caloric effect produced by soybean oil or molasses can reduce food consumption, increase the time of ingestion in the digestive tract improving your digestion. A disadvantage of soybean oil for making guinea pig feed is its price compared to molasses. Using 3 or 4% molasses in food for guinea pigs is common, it is an adequate caloric intake and higher doses can cause the rejection of the food; furthermore, it is possible that guinea pigs may like the aroma of molasses.

Guinea pigs need vitamin C to meet their maintenance needs and to keep their health balanced. León *et al*. (2016) evaluated 450, 550 and 660 mg/kg of feed and conclude that 450 mg/Kg cover the requirements in guinea pigs. This amount is a high dose, compared to that used in the present study of 100 and 300 mg/kg of food without showing negative signs in the animals. It is possible that the doses of vitamin C are not adequate and the animals have lower requirements. Silva and León (2015) compared 500 to 1100 mg of vitamin C in kg of balanced food, a dose ten times higher than that used, and found greater food consumption and weight gain at 900 mg per kg of food. In the present experiment, a similar effect was presented when increasing from 100 to 300 mg of vitamin C, but only the first week.

There are different approaches to the levels of vitamin C that guinea pig feed should contain. The NRC (1995) suggests 200 mg/kg of food in balanced diets, approximate doses to those used in this study. The doses of vitamin C used in this experiment possibly did not cause apparent lesions or deficiencies in the four treatments, due to the exposure time of the guinea pigs and proper handling of the animals. Mattos *et al*. (2003) mention that vitamin C levels should increase according to the stress that the individual has, mainly when there are sudden changes in temperature or intense driving. Guevara *et al*. (2014) used 50 and 100 mg/Kg of feed without having an effect on the weight of the animals; Similar results to those reported in the present experiment at doses of 100 and 200 mg/Kg. However, León *et al*. (2016) evaluated 0, 450, 550 and 660 mg/kg of vitamin C with higher food consumption and weight at the 450 mg/kg dose. The NRC (1995) suggests 200 mg per kg, but they have increased the dose to 800 mg, reporting weight gain at 200 and 350 mg. The results obtained in the investigations vary due to the ingredients used to elaborate the foods that can affect the consumption of the guinea pigs and their yields.

The hair in guinea pigs has aesthetic importance because it indicates their state of nutrition and general health. Vivas and Carballo (2013) recommend vitamin C administered through food every day with doses according to its productive stage to avoid hair loss.

In the present study, no nutritional deficiencies were observed in capillary permanence in its different growth stages at the end of the experiment. This can be explained by a correct nutrition and maintenance of the organism that feeds the collagen cycle to maintain the adequate hair follicle that projects a phenotypic and genotypic capillary expression adequate to the species studied in anagen (Grosso *et al*., 2013).

CONCLUSION

The addition of soybean oil or molasses as a concentrated source of energy combined with 100 or 300 mg of vitamin C per kg of pellet feed does not affect body weight, feed consumption or capillary permanence in guinea pigs. However, it is necessary to continue investigating the amount and type of energy used in specialized foods for the species with different doses of vitamin C.

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CITED LITERATURA

AIRAHUACHO BFE, Vergara RV. 2017. Evaluación de dos niveles de energía digestible en base a los estándares nutricionales del NRC (1995) en dietas de crecimiento para cuyes (*Cavia porcellus L*). *Revista de Investigaciones Veterinarias del Perú.* 28(2):255-26. https://doi.org/10.15381/rivep.v28i2.13079

BONILLA QS, Usca MJ. 2015. Utilización de diferentes niveles de maíz de desecho con tusa molida más melaza en la alimentación de cuyes. *Revista ciencia UNEMI*. 8(15):96-101. ISSN: 1390-4272. https://dialnet.unirioja.es/servlet/articulo?codigo=5269484

CAMINO JM, Hidalgo VL. 2014. Evaluación de dos genotipos de cuyes (*Cavia porcellus*) alimentados con concentrado y exclusión de forraje verde. *Revista de investigaciones veterinarias del Perú*. 25(2):190-197. ISSN: 1609-9117. https://www.redalyc.org/pdf/3718/371834046006.pdf

CHAUCA ZL. 1997. *Producción de cuyes (Cavia porcellus)*. La Molina, Perú. Food & Agriculture Organización. Pp. 150. ISBN 92-5-304033-5. http://www.fao.org/3/W6562S/W6562S00.htm

GUEVARA J, Díaz P, Bravo N, Vera M, Crisóstomo O, Barbachán H, Huamán D. 2013. Uso de harina de pajuro (*Erithrina edulis)* como suplemento en la alimentación de cuyes – Lima. *Revista Peruana Química e Ingenieria Química*. 16(2):21-28. https://es.scribd.com/document/396423424/Uso-de-Harina-de-Pajuro-Erythrina-Edulis-Como-Suplemento-en-La-Alimentacion-de-Cuyes-Lima

GUEVARA VJ, Lozano HV, Valenzuela J. 2014. Evaluación de dos niveles de vitamina c en la alimentación de cuyes (*Cavia porcellus*) en crecimiento sin forraje verde. *Anales Científicos*. 75(2):471-474. ISSN: 2519-7398. http://dx.doi.org/10.21704/ac.v75i2.988

GROSSO G, Bei R, Mistretta A, Marventano S, Calabrese G, Masuelli L, Gazzolo D. 2013. Effects of vitamin C on health E; a review of evidence. *Front biosci.* 1(8):1017-1029. https://doi.org/10.2741/4160

HARWOOD R, Grant ME, Jackson DS. 1973. Collagen biosynthesis in healing wounds of guinea pigs recovering from Vitamin C deficiency. *Biochemical Society Transactions*. 1(5):1217-1219. https://doi.org/10.1042/bst0011217

JACKSON D, Ebling FJ. 1971. The guinea-pig hair follicle as an object for experimental observation. *Journal Society Cosmetic Chemicals*. 22: 701-709. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.508.1874&rep=rep1&type=pdf

LEÓN Z, Silva E, Wilson A, Callacna M. 2016. Vitamina C protegida en concentrado de *Cavia porcellus* "cuy" en etapa de crecimiento-engorde, con exclusión de forraje. *Scientia Agropecuaria*. *7:*259-263. https://doi.org/10.17268/sci.agropecu.2016.03.14

MARSANASCO M, Márquez A, Wagner J, Alonso S, Chiaramoni N. 2011. Liposomes as vehicle for vitamins E and C: An alternative to fortify orange juice and offer C protection after heat treatment. *Food research international*. 44(9):3039-3046. https://doi.org/10.1016/j.foodres.2011.07.025

MATTOS CJ, Chauca FL, San Martín HF, Carcelén CF, Arbaiza FT. 2003. Uso del ensilado biológico del pescado en la alimentación de cuyes mejorados. *Revista de investigaciones veterinarias del Perú.* 14(2):89-96. http://www.scielo.org.pe/scielo.php?script=sci_arttext&pid=S1609-91172003000200001&lng=es&nrm=iso

MEZA BGA, Cabrera VPR, Morán MJJ, Meza BFFF, Cabrera VCA, Meza BCJ, Meza BJS, Cabanilla CMG, López MFX, Pincay JJL, Bohórquez BT, Ortiz DJ. 2014. Mejora de engorde de cuyes (*Cavia porcellus*) a base de gramíneas y forrajeras arbustivas tropicales en la zona de Quevedo, Ecuador. *Idesia (Arica)*. 32(3):75-80. https://doi.org/10.4067/S0718-34292014000300010

MORALES MA, Carcelén CF, Ara GM, Arbaiza FT, Chauca FL. 2011. Evaluación de dos niveles de energía en el comportamiento productivo de cuyes (*Cavia porcellus)* de la raza Perú. *Revista de investigaciones veterinarias del Perú*. 22(3):177-182. http://www.scielo.org.pe/scielo.php?script=sci_arttext&pid=S1609-91172011000300001&lng=es&nrm=iso

NRC (National Research Council). 1995. Requerimientos nutritivos del cuy. 4ta ed. Washington D.C.: National Academy Press. NRC. Pp. 192. http://www.fao.org/livestock/agap/frg/nrcnut.htm

NORMA Oficial Méxicana NOM-062-ZOO-1999. Especificaciones técnicas para la producción, cuidado y uso de los animales de laboratorio. https://www.gob.mx/cms/uploads/attachment/file/203498/NOM-062-ZOO-1999_220801.pdf

QUINTANA E, Jiménez R, Carcelén F, San Martín H, Ara M. 2013. Efecto de dietas de alfalfa verde, harina de cebada y bloque mineral sobre la eficiencia productiva de cuyes. *Revista de Investigaciones Veterinarias del Perú*. 24(4): 425-432. http://www.scielo.org.pe/pdf/rivep/v24n4/a03v24n4.pdf

RESÉNDIZ MRI, Hernández JDM. 2008. Los cuyes (*Cavia porcellus*) como animales de compañía. Revista Asociación de Médicos Veterinarios Especialistas en Pequeñas Especies. 19(1):22-25. https://www.imbiomed.com.mx/articulo.php?id=49879

REYES SN, Vivas J, Aguilar J, Hernández J, Caldera N. 2018. Suplementación de cobayos (*Cavia porcellus L.)* con forrajes frescos de morena (*Morus alba)* y moringa (*Moringa oleífera). La calera*. 18(30):7-13. https://www.researchgate.net/publication/334066742_Suplementacion_de_cobayos_Cavia_porcellus_L_con_follajes_fresco_de_morera_Morus_alba_y_moringa_Moringa_oleifera

SAS Institute. 2010. *Statistical Analysis Software SAS/STAT*®. version 9.0.2, Cary, N.C., USA: SAS Institute Inc., ISBN: 978-1-60764-599-3. http://www.sas.com/en_us/software/analytics/stat.html#

SÁNCHEZ A, Zambrano D, Torres E, Meza G. 2012. Forrajes tropicales y banano maduro (*Musa paradisiaca)* en el engorde de cuyes (*Cavia porcellus L.)* en el cantón Quevedo. Actas *Iberoamericanas de Conservación Animal.* 2:287-290. http://www.uco.es/conbiand/aica/templatemo_110_lin_photo/articulos/2012/Trabajo057_AICA2012.pdf

SILVA SJE, León GZ. 2015. Efecto de tres niveles de vitamina C de un concentrado comercial sobre el incremento de peso de *Cavia porcellus* "CUY" en la etapa de crecimiento y engorde. Tesis Ingeniero Agrónomo Zootecnista. Facultad de Ciencias Agropecuarias, Universidad Nacional de Trujillo, Perú. Pp. 56. http://dspace.unitru.edu.pe/bitstream/handle/UNITRU/3029/SILVA%20SÁNCHEZ%2C%20José%20Enrique.pdf?sequence=1&isAllowed=y

TARRILLO EBP, Mirez PKF, Bernal MW. 2018. Uso de alimento peletizado en crecimiento-engorde de cuyes mejorados (*cavia porcellus*) en chota. *Revista Ciencia No@ndina.* 1(2): 94-103. https://doi.org/10.37518/2663-6360x2020v1n2p94

VIVAS TJA, Carballo D. 2013. Especies Alternativas: Manual de crianza de cobayos (*Cavia porcellus*). Universidad Nacional Agraria. Pp. 49. ISBN: 9789992410226. https://www.researchgate.net/publication/311349387_Manual_de_crianza_de_cobayos