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Productive parameters of rabbits fed with different parts of the *Tithonia tubaeformis* plant

Parámetros productivos de conejos alimentados con diferentes partes de la planta *Tithonia tubaeformis*

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ABSTRACT

Tithonia tubaeformis has been studied little in general, as far as is known it has not been used in the feeding of rabbits. It is, for this reason, the aim of this study to use different parts of *Tithonia tubaeformis* plant in the feeding of rabbits with the purpose of observing the effect on the productive parameters in fattening animals. 48 rabbits of the races New Zealand, California and Mariposa were used, distributed in 4 treatments. Production parameters were measured during fattening, and morphometric and yield measurements of the carcass were also made. The results indicate that there are no significant differences ($P > 0.05$) of all the variables measured, but there is a tendency to improve the productive parameters of rabbits by including *Tithonia tubaeformis* leaves in their diet. Therefore, it is concluded that this plant can be used in the feeding of fattening rabbits without presenting adverse productive effects.

Keywords: *Tithonia tubaeformis*, rabbit, productive parameters.

RESUMEN

Tithonia tubaeformis se ha estudiado poco en general, hasta donde se tiene conocimiento no se ha empleado en la alimentación de conejos. Es por ello con el objetivo de este estudio utilizar diferentes partes de la planta de *Tithonia tubaeformis* en la alimentación de conejos con la finalidad de observar el efecto sobre los parámetros productivos en animales de engorda. Se utilizaron 48 conejos de las razas Nueva Zelanda, California y Mariposa, distribuidos en 4 tratamientos. Se midieron parámetros productivos durante la engorda, también se realizaron mediciones morfométricas y de rendimiento de la canal. Los resultados indican que no existen diferencias significativas ($P > 0.05$) de todas las variables medidas, pero existe una tendencia a mejorar los parámetros productivos de los conejos al incluir en su dieta hojas de *Tithonia tubaeformis*. Por ello se concluye que esta planta puede ser empleada en la alimentación de conejos de engorda sin presentar efectos productivos adversos.

Palabras clave: *Tithonia tubaeformis*, parámetros productivos, conejos.

INTRODUCTION

Rabbit meat has several advantages with respect to the meat of other species, it is known that this meat has a better profile of fatty acids; in addition to the amount of protein, vitamins, minerals, its low content of cholesterol and sodium; coupled with the lack of uric acid (Para, 2015). Despite the qualities described above of rabbit meat, its consumption and production is relatively low, since Armada (2016) indicates that the per capita consumption in Mexico fluctuates between 30 and 134 g; it is also known that rabbit production in the country is centralized in states such as Hidalgo, Puebla, Estado de México and Guanajuato. It has also been recognized that various governmental and non-governmental institutions encourage the production and consumption of this meat, either fresh or through various meat products. However, one of the main problems of rabbits, as in other animal species is the cost of feeding; coupled with this, the scourge of some digestive problems of the rabbit. One of the ways to alleviate these problems is the search for new food alternatives, such as the use of plants that are a problem of weeds in crops, mainly corn.

The *Tithonia* genus is distributed mainly in Mexico and Central America; eleven species are recognized divided into two groups, including annual and perennial plants. The plant *Tithonia tubaeformis* is an herbaceous plant, annual, with stems of 1 to 3 m, round with colors from yellow to brown, alternate leaves of 2 to 11 cm, peduncles of 10 to 45 cm long and 4 to 11 mm in diameter (Figure 1). Its flowering period is from August to November (Duke, 1982); also according to Sánchez-Blanco and Guevara-Fefer (2013) is a weed in corn crops, which represents a competition for soil nutrients.

There is no evidence of reports that this plant is used in the feeding of rabbits, however, Garcia *et al.* (2016) found this plant in the botanical composition of the diet of grazing goats in a xerophilous scrub. This plant is used in traditional medicine, Gheno-Heredia *et al.* (2011) mention that the leaves are used to alleviate skin problems, while Bello-González *et al.* (2015) indicates that the cooked flower can be used to relieve digestive problems. However, Hinojosa *et al.*, (2013) studied this plant to know the presence of phytochemical compounds from methanol: water extracts; finding that the main phenols present are pyrogallol and catechol type, which have a high anti-inflammatory response.

Taking into account these antecedents, the aim of this study was to use different parts of the *Tithonia tubaeformis* plant in the feeding of rabbits, with the purpose of observing the effect on the productive parameters, the morphometric characteristics and the carcass yield in fattening animals.



Figure 1. *Tithonia tubaeformis*

MATERIAL AND METHODS

Animals and diets

The animals in this study were housed in the experimental farm of the Institute of Agricultural Sciences (Tulancingo, Hidalgo, Mexico). The care and handling of the rabbits was in accordance with the guidelines of the ethics committee of the Autonomous University of Hidalgo State. We used 48 weaned rabbits (35 d of age), New Zealand, California and Mariposa breeds, with an average weight of 1165.52 ± 124.07 g, which were assigned completely randomly to four treatments ($n = 12$ per treatment): control (C), leaves (L), stems (S) and complete plant (CP), as indicated in Table 1. The rabbits were kept in pens (90 x 60 x 40 cm) equipped with manual feeders and automatic drinkers. The average temperature in the experimental place was 20 ° C and 65% relative humidity. The food was pelleted in a model machine SKJ120 (Shandong, China). The diets were isoproteic (16% PC) and isoenergetic (2.3 Mcal kg MS⁻¹ of digestible energy).

Productive parameters

During the experiment the animals were weighed each week, while the daily food intake was determined, weighing the food offered and rejected. From these data, the daily weight gain during the four weeks of fattening, total gain and feed conversion during the fattening period were calculated. At the end of the fattening, the rabbits were slaughtered with an average age of 63 d of age; for this they were transported to the meat workshop of the Institute of Agricultural Sciences in Tulancingo, Hidalgo, Mexico. The rabbits were slaughtered without previous fasting, were weighed, stunned and

processed according to the current regulations (NOM-033-SAG / ZOO-2014). The weight of the hot carcass was calculated from the data obtained.

Statistical analysis

All the data were analyzed under a completely randomized design, to which an analysis of variance was performed by means of a GLM procedure (SAS, 2004). When there were differences, a comparison of Tukey's means was made, with a level of significance of $P < 0.05$.

Table 1. Experimental diets based on *Tithonia tubaeformis*

Ingrediente	Treatments			
	Control	Leave	Whole plant	Stems
	(% Dry base)			
<i>Tithonia tubaeformis</i>	0.0	11.2	11.2	11.3
Alfalfa hay	10.2	0.0	0.0	0.0
Barley straw	10.1	10.0	9.2	10.7
Ground corn	20.0	18.2	17.0	19.2
Canola paste	3.9	3.9	3.9	4.0
Soybean paste	17.0	18.0	20.1	16.1
Ground sorghum	17.9	17.9	17.9	17.9
Molasses	1.0	1.0	1.0	1.0
Soybean husk	10.8	10.8	10.8	10.8
Wheat bran	6.5	6.5	6.5	6.5
Mineral and vitamin premix	2.5	2.5	2.5	2.5

RESULTS AND DISCUSSION

The results of the productive parameters of fattening rabbits fed with different parts of the *Tithonia tubaeformis* plant can be seen in Table 2. No significant differences were observed ($P > 0.05$) between the treatments; however, there is a tendency to have lower feed consumption during the first week of the fattening period of the rabbits that consumed the different parts of the *Tithonia tubaeformis* plant with respect to the control treatment; subsequently, rabbits fed with plant leaf tended to present lower feed consumption, which coincides with the total food consumption, being the treatment that consumed the least food. It should be mentioned that the lower consumption resulted in lower weight gain.

Because there are no differences between the treatments, it can be said that the use of *Tithonia tubaeformis* in the feeding of rabbits in fattening is a feeding alternative, which coincides with that reported by Duilio *et al.*, (2011), who using flour of *Tithonia diversifolia* in fattening rabbits did not obtain differences in consumption, neither in daily gain of weight, with respect to the control.

In other works within the research group, similar results have been obtained to those shown here with other plants, such as the inclusion of plants in the feeding of fattening rabbits under the same experimental conditions, as in the case of epazote (García-

Vázquez *et al.*, 2017), mint, chamomile, rue or ginger (unpublished data). In these works it has been observed that the inclusion of plants can improve or have productive parameters similar to those of the control treatment, this suggests that *Tithonia tubaeformis* and other medicinal plants can have beneficial effects on the health of rabbits, since these plants can present phenols that make the digestive system of the rabbit healthy and respond appropriately to have productive parameters that encourage its use during fattening.

In Table 3, the morphometric measurements of live animals and their corresponding in the carcass of rabbits fed with various parts of *Tithonia tubaeformis* can be seen. Live weight, weight and carcass yield are also included. Unlike what Molina *et al.* (2018) reported in relation to the length of the carcass, which was greater as the amount of amaranth in the diet of rabbits in fattening increases at 87 d. As regards other morphometric measurements, no differences were found.

Table 2. Productive parameters of rabbits fed with *Tithonia tubaeformis*

Variable	Treatments			
	Control	Leave	Whole plant	Stem
CAS 1 (g)	704.33 ± 48.0	641.33 ± 74.6	661.00 ± 86.5	668.00 ± 114.7
CAS 2 (g)	739.33 ± 178.6	721.33 ± 76.7	798.67 ± 55.3	774.67 ± 34.8
CAS 3 (g)	789.00 ± 76.9	822.67 ± 74.3	898.67 ± 121.7	838.33 ± 39.2
CAS 4 (g)	885.00 ± 74.5	848.33 ± 43.2	828.33 ± 59.6	899.67 ± 38.2
CTA (g)	3117.33 ± 334.7	3033.67 ± 141.4	3186.00 ± 95.2	3180.67 ± 145.2
GDP1 (g d ⁻¹)	43.98 ± 9.5	37.92 ± 8.6	37.78 ± 20.2	37.14 ± 12.6
GDP2 (g d ⁻¹)	30.77 ± 29.8	36.50 ± 15.9	36.82 ± 10.1	41.69 ± 9.9
GDP3 (g d ⁻¹)	36.00 ± 24.2	31.04 ± 5.8	34.80 ± 18.1	34.20 ± 4.1
GDP4 (g d ⁻¹)	35.24 ± 10.9	30.95 ± 4.8	28.36 ± 9.1	32.15 ± 12.0
GDPTotal (g d ⁻¹)	36.50 ± 7.5	34.10 ± 4.3	34.44 ± 7.4	36.29 ± 4.9
Gained weight (g)	1022.08 ± 211.8	955.00 ± 120.8	964.44 ± 207.8	1016.36 ± 139.3
Food conversion	3.18 ± 0.7	3.21 ± 0.4	3.41 ± 0.6	3.18 ± 0.3

CAS = Weekly food consumption, CTA = Total food consumption, GDP = Daily weight gain.

Mean ± standard error. Tukey (P<0.05).

Table 3. Morphometric measurements of the animal and the carcass of rabbits fed with *Tithonia tubaeformis*

Variable	Treatments			
	Control	Leave	Whole plant	Stem
Live weight (g)	2166.25 ± 260.9	2087.50 ± 163.1	2186.00 ± 236.8	2231.20 ± 169.4
Length (cm)	32.58 ± 3.0	31.15 ± 2.4	32.30 ± 3.6	33.35 ± 2.1
Hip circumference (cm)	25.58 ± 1.9	26.10 ± 1.9	26.50 ± 1.3	25.90 ± 1.9
Lumbar circumference (cm)	21.96 ± 2.3	21.80 ± 2.3	22.60 ± 0.5	22.25 ± 2.1
Skin (g)	320.00 ± 48.1	305.50 ± 21.5	338.40 ± 40.3	332.20 ± 43.6
Legs (g)	55.25 ± 12.6	48.50 ± 4.4	51.60 ± 6.5	54.20 ± 7.6
Long carcass (cm)	31.58 ± 1.8	33.45 ± 2.0	32.50 ± 1.9	33.50 ± 2.2
Circumference hip carcass (cm)	26.58 ± 9.1	25.05 ± 1.8	23.90 ± 2.6	24.75 ± 1.2
Lumbar circumference carcass (cm)	16.46 ± 1.4	16.60 ± 0.9	16.10 ± 0.5	16.85 ± 0.7
Hot carcass weight (g)	1198.75 ± 180.4	1148.50 ± 101.1	1206.00 ± 114.9	1231.50 ± 87.1
Yield (%)	59.86 ± 2.6	60.07 ± 2.3	60.48 ± 4.0	60.07 ± 1.3

Mean ± standard error. Tukey (P<0.05).

CONCLUSION

According to the results found in this study, it can be concluded that the *Tithonia tubaeformis* plant can be used in the feeding of fattening rabbits without deteriorating their health and with similar production parameters to the control treatment. However, a tendency was found to obtain better productive parameters, when using the leaf of this plant and the carcass weight when consuming the whole plant. Therefore, these results allow us to continue investigating other productive aspects as well as quality of the carcass in rabbits fed with *Tithonia tubaeformis*; as well as the properties of this plant, or extracts thereof, which allow its use in the feeding of fattening rabbits or in other areas.

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