

EFFECT OF LUPINUS MUTABILIS (CHOCHO) ON THE LACTATION
AND GROWTH OF RABBITS AND GUINEA PIGS

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Introduction

Soybeans, the protein source most universally used in animal feeds, do not yield well on the high Andean farms (2,700 - 4,200 m) of Ecuador, Peru, and Bolivia. Hence, an alternative source of feed protein is needed by the self-sufficient farmers of the region. One such source is the lupin, *Lupinus mutabilis*, known commonly as chocho or tarwi which is native to the area. Comparatively, chochos contain more protein than soybeans, 42 versus 38%, and approximately the same level of fat, 15 versus 18%. However, the essential amino levels of chochos lag behind those of soybeans. For example, the methionine and lysine levels of soybeans are .54 and 2.40% versus .38 and 1.96% respectively for chochos. Chocho crop yields are quite acceptable. In the high and somewhat arid climes of the Andean mountains yields of 1800 kg/hectare are not uncommon. It is oft times planted as a border crop because of the plant's and seed's high alkaloid content which provides a very bitter taste and discourages grazing animals from proceeding further. Chochos are popularly consumed by the indigenous people. However because the taste of the bean is so objectionable, it must be debittered before it is consumed. This is done by soaking the beans for several days in a water bath that leaches out the alkaloids which are water soluble. In their bitter state chochos contain about 2% alkaloids.

In the current research, it was hypothesized that feeds based on chochos for lactating and growing rabbits and guinea pigs would yield performances

similar to those based on soybean meal. /Seroux, 1984/ feeding a European variety of lupin to growing rabbits noted similar gains as from soybean meal. Rabbits are gaining in popularity as a meat source among the Andean people. Guinea pigs, which are indigenous to this area, have been a popular dietary food for centuries.

Materials and Methods

The following tests were conducted in the Ecuadorean Sierra at the Escuela Superior Politecnica de Chimborazo.

Rabbits

Rabbit trials were conducted with lactating does and weaned kits (Table 1). In the lactation trial, nine medium sized does of New Zealand and Californian breeding were equally divided into the three treatments at the time of kindling. Only does of litter sizes 5 to 7 were used in the treatments. The rabbits were individually penned in cages 91 cm x 76 cm x 46 cm. The does and litters were fed pelleted late bloom alfalfa hay and nonpelleted concentrate free choice. Water was available ad libitum. Does and their litters were weighed weekly.

A second trial was conducted with 24 weaned New Zealand and Californian kit rabbits of four to five weeks of age. They were equally divided into the four treatments by number and by sex. They were housed in pairs in cages 51 cm x 51 cm x 46 cm. The rabbits were fed concentrate (Table 2) free choice and 150 grams each of 25% DM full bloom alfalfa hay daily. Water was available continuously. Rabbits were weighed individually weekly.

In the trial chochos were fed raw, toasted, and debittered. The beans are thought to contain very modest antitryptic and urease activity. They were toasted in an effort to destroy that activity. Toasting was done on a skillet over an open fire in the same fashion as done by the indigenous people. For the debittered treatment, the alkaloids were removed by water leaching (Table 3). The beans were submerged in a water bath for three days. The water was changed twice daily. On the fourth day, the beans were boiled for 30 minutes. Thereafter, the beans were bathed for another three days at which time they were completely devoid of the bitter taste.

Guinea Pig Trials

Trials were conducted with both lactating and growing guinea pigs. Twelve first-litter, pregnant guinea pig sows were individually caged and divided into four nutritional treatments (Table 4). Feeding commenced approximately one week prior to farrowing. They were housed individually in pens 45 cm x 45 cm x 40 cm. The sow and her young were fed nonpelleted concentrate and water free choice (Table 2) plus 100 grams of 25% DM full bloom fresh cut alfalfa daily. The young were weighed daily for the first 14 days postfarrowing and the adults weekly.

For the growth trial, 40 fourteen to twenty-one day old guinea pigs were divided equally by number and by sex into five treatments. They were kept by pairs in floor pens 45 cm x 45 cm x 40 cm. There they were given nonpelleted concentrate (Table 2) and water ad libitum. In addition, each animal received 100 grams of fresh cut 25% DM full bloom alfalfa hay daily. Pigs and feed were weighed weekly during the eight week trial. The toasted and debittered chochos were prepared as mentioned in the rabbit trial. In this trial there was an additional treatment of toasted debittered chochos. The chochos were first toasted to destroy the antinutritional factors, if any, and then bathed in water for three days to leach out the alkaloids (Table 5). Animal weights and feed consumption were determined on a weekly basis.

The data were analyzed by analysis of variance and the differences in means by Duncan's Multiple Range test.

Results and Discussion

Rabbits

Feeding raw chochos did not support lactation as well as did feeding soybeans or soybean meal (Table 6). For the first three weeks postkindling kits rely almost entirely upon the milk of the doe as their source of nutrition. Three-week-old kit weights of chocho-fed does were substantially ($P < .05$) lower than those of does fed either soybeans or soybean meal. Feed consumption between these groups was quite similar; but there was, however, of those fed chochos a tendency to sift through their feed to eat the alfalfa pellets in lieu of the chocho. A fair amount of feed wastage ensued. Consequently due to the low body weights of the chocho-fed kits and the tendency of their does to poorly utilize feed, the conversion of feed to gain

by this group was materially higher than that of the other treatments. Though chochos supported growth poorly, mortality of kits was not different from that of feeding soybeans or soybean meal.

In the growth trial, feeding debittered chochos resulted in average daily gains similar to those realized from feeding soybean meal (Table 7). However, feeding the non debittered lupin whether in the raw or toasted form resulted in significantly ($P<.05$) lower gains that were substantially less. The feeding system lent itself to considerable wastage, as a result the conversions of feed to gain were quite high. Alfalfa hay was fed freshly cut in the cage, and the concentrate was fed in the mash rather than pelleted form. /Seroux, 1984/ feeding a European variety of raw lupin found rabbits to gain as well and convert feed to gain as effectively as those consuming diets based on soybean meal. Most European lupins are classified as sweet. Through genetic selection, sweet varieties have been developed with very low alkaloid content.

Guinea Pigs

None of the chocho treatments (Table 8) supported the lactation of guinea pig sows as well as soybean meal ($P<.05$). Feeding debittered chochos, however, resulted in significantly ($P<.05$) superior gains than realized from feeding the high alkaloid raw and toasted lupin. Much of the lower gains observed for the high alkaloid treatments was due to a suppressed feed intake that was significantly ($P<.05$) lower for those two groups.

From debittered beans, guinea pigs were able to grow as rapidly as from consuming soybean meal based diets (Table 9). The gains were lower but statistically similar. As with the lactating guinea pigs, there was a tendency toward depressed intake from feeding the high alkaloid beans and statistically ($P<.05$) lower daily gains.

Conclusion

In tests conducted in the Sierra of Ecuador, lactating and growing rabbits and guinea pigs were fed diets based upon the bitter lupin *Lupinus mutabilis* commonly know as chocho or tarwi. In the high alkaloid bitter state, *L. mutabilis* would not support kit growth of rabbits or guinea pigs during lactation and following weaning as well as did feeding soybean meal.

Feeding the debittered lupin (alkaloids leached by water bath) resulted in gains for weaned rabbits, nursing and weaned guinea pigs similar to those achieved from feeding soybean meal.

References

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Table 1. Experimental Design Rabbit Trials

Treatments	Lactation Trial	Growth Trial
	Litters/Treatment	Animals/Treatment
Soybean meal	3	6
Soybeans, raw	3	
Chochos, raw	3	6
Chochos, toasted		6
Chochos, debittered		6

Table 2. Experimental Diets Rabbits and Guinea Pigs

Ingredients	Soybean Meal	Raw Soybeans	Chochos*
	%	%	%
Corn	66.8	61.3	64.5
Soybean meal	27.2		
Soybean, raw		32.7	
Chochos			29.0
Bone meal	4.8	4.8	4.8
Salt	.5	.5	.5
Premix (Vitamin & Min.)	.7	.7	.7
Protein	18 %	18 %	18 %
Calcium	1.49	1.49	1.48
Phosphorus	1.03	1.03	1.03
Methionine	.28	.28	.22
Lysine	.96	.96	.74

* Chochos -- raw, debittered, toasted and toasted debittered

Table 3. Debitter Raw Chochos

1. Soak in water bath three days
2. Boil for 30 minutes
3. Soak in water bath until bitter taste is removed
(approximately 3 day)
4. Sun dried

Table 4. Experimental Design Guinea Pig Trials

Treatment	2 Week	8 Week	
	Lactation Trial	Grow Trial	
	Litters/Treatment	Females	Males
Soybean meal	3	4	4
Chochos, raw	3	4	4
Chochos, toasted	3	4	4
Chochos, debittered	3	4	4
Chochos, toasted debitter		4	4

Table 5. Debittered Toasted Chochos

1. Soak in water bath for three days until taste is removed.
2. Sun dried

Table 6. Effect of Chochos on the Lactation of Rabbits (Three Weeks)

Treatment	Kit	Doe	Feed/Gain
	Average Daily	Average Daily	
	Gain	Feed Intake	
	(g)	(g)	
Soybean meal	14.0 a	77.2	5.51 a
Soybeans, raw	12.3 b	73.3	5.96 a
Chochos, raw	6.9 c	79.0	11.45 b

Means followed by unlike letters are significantly different (P<.05)

Table 7. Effect of Chochos on the growth of Rabbits (Four Week)

Treatment	Mortality #	Average Daily Gain (g)	Average Daily Feed Intake (g)	Feed/Gain
Soybean meal	0	26.3 a	122.0 c	4.64 a
Chocho, raw	33%	16.4 b	142.5 b	8.69 b
Chocho, toasted	0	11.8 b	99.5 d	8.4 b
Chocho, debittered	0	27.5 a	161.1 a	5.86 a

Means followed by unlike letters are significantly different (P<.05)

Table 8. Effect of Chochos on the Lactation of Guinea Pigs (Fourteen day)

Treatment	Litters #	Average Daily Gain (g)	Average Daily Feed Intake ^a (g)	Feed Intake
Soybean meal	3	10.5 a	38.4 a	3.68 a
Chochos, raw	3	2.4 d	23.2 c	9.62 c
Chochos, toasted	3	4.9 c	21.0 c	4.29 b
Chochos, debittered	3	6.7 b	31.9 b	4.76 b

^a Includes sow and kit feed intake

^b Means followed by unlike letters are significantly different (P<.05)

Table 9. Effect of Chochos on the Growth of Guinea Pigs (Eight Weeks)

Treatment	Animals #	Average Daily Gain (g)	Average Daily Feed Intake (g)	Feed Intake
Soybean meal	8	5.4 a	34.8 a	6.43 a
Chochos, raw	8	4.0 c	28.2 ab	7.05 a
Chochos, toasted	8	3.2 b	26.4 b	8.15 b
Chochos, debittered	8	4.8 ab	34.3 a	7.25 ab
Chochos, toasted debittered	8	4.9 ab	30.5 a	6.17 a

Means followed by unlike letters are significantly different (P<.05)

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Lupinus mutabilis, a bitter lupin native to South America and known commonly as chocho or tarqui, was fed as the major source of protein to rabbits and guinea pigs. *L. mutabilis* contains 42% protein, 15% fat, .38% methionine and 1.96% lysine compared to 38, 18, .54% and 2.40% for soybeans. Diets based on soybean meal, raw soybeans, and raw lupin were fed to lactating does for three weeks post kindling. Feeding soybean meal resulted in three week kit gains (294.8 grams) significantly ($P<.05$) greater than for kits fed soybeans (258.7 grams) and lupin (145.1 grams). Soybean kits gained significantly more than those fed lupin. Two to six week old weaned kits were fed either soybean meal, raw lupin, toasted lupin or debittered lupin based diets for four weeks. Kits fed the soybean meal and debittered lupin diets gained significantly ($P<.05$) more weight (723.8 and 769.3 grams) than those fed raw (456 grams) or toasted (329.8 grams) lupin. Soybean meal, raw lupin, toasted lupin, debittered lupin and debittered toasted lupin were fed to lactating guinea pig females and their litters for 14 days post farrowing and to growing guinea pigs post weaning for eight weeks. Nursing pigs fed soybean meal gained significantly ($P<.05$) more weight (146 grams) than those fed debittered lupin (93.8 grams), toasted lupin (68.3 grams) and raw lupin (33.7 grams). They also required significantly less feed per unit of gain than those fed the various lupin diets. Feeding soybean meal and toasted debittered lupin diets to growing guinea pigs induced greater gains (302 and 276.4 grams) than when fed raw (223 grams) and toasted (182.2 grams) lupin. In summary, raw lupin will not support growth of lactating or weaned rabbit kits or guinea pigs as well as soybean meal. However, debittering the beans resulted in growth similar to that observed from soybean meal except in the case of nursing guinea pigs.

EFFET DE LUPINUS MUTABILIS (CHOCHO) SUR LA LACTATION
ET LA CROISSANCE DES LAPINS ET DES COCHONS D'INDE

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Lupinus mutabilis, un lupin amer, originaire d'Amérique du Sud et connu sous le nom de chocho ou tarqui a été donné comme source principale de protéine à des lapins et à des cochons d'Inde. *L. mutabilis* contient 42% de protéine, 15% de matières grasses, .38% de méthionine et 1.96% de lysine par comparaison avec le soja qui en contient 38, 18, .54% et 2.4%. Des régimes à base de semoule de soja, de soja cru, et de lupin cru ont été appliqués à des lapines allaitantes pendant trois semaines après la mise-bas. Après trois semaines le résultat du régime de semoule de soja fut un gain de poids (294,8 grammes) définitivement ($P<.05$) plus élevé que celui des lapereaux nourris de soja (258,7 grammes) et de lupin (145.1 grammes). Les lapereaux qu'on avait nourris de soja prirent beaucoup plus de poids que ceux qui avaient reçu du lupin. Pendant quatre semaines, des régimes à base de semoule de soja, de lupin cru, de lupin grillé, ou de lupin auquel on avait enlevé ses propriétés amères furent appliqués à des lapereaux sevrés âgés de

deux à six semaines. Les lapereaux recevant la semoule de soja et le lupin non amer prirent définitivement ($P < .05$) beaucoup plus de poids (723,8 et 769,3 grammes) que ceux qui avaient reçu du lupin cru (456 grammes) ou du lupin grillé (329,8 grammes). De la semoule de soja, du lupin cru, du lupin grillé, du lupin non amer, et du lupin non amer grillé furent donnés à des cochons d'Inde femelles allaitant et à leurs portées pendant 14 jours après la mise-bas et à des cochons d'Inde en croissance pendant huit semaines après le sevrage. Les cochons non sevrés qui reçurent de la semoule de soja prirent beaucoup plus ($P < .05$) de poids (146 grammes) que ceux qui reçurent du lupin non amer (93,8 grammes), du lupin grillé (68,3 grammes) et du lupin cru (33,7 grammes). Il fallut aussi leur donner beaucoup moins de nourriture par unité de gain qu'à ceux qui reçurent les divers régimes de lupin. Les régimes de semoule de soja et de lupin non amer grillé appliqués aux cochons d'Inde pendant leur croissance produisirent des gains plus élevés (302 et 276,4 grammes) que ceux des animaux recevant du lupin cru (223 grammes) et du lupin grillé (182,2 grammes). En conclusion, le lupin cru produit moins de croissance que la semoule de soja chez les lapines allaitant, les lapereaux sevrés ou les cochons d'Inde. Cependant, l'extraction des propriétés amères du soja résulta en une croissance semblable à celle qu'on observa comme résultat de la semoule de soja excepté dans le cas des cochons d'Inde non sevrés.

