Rabbit researches at the Instituto de Ciencia Animal

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Rabbit researches at the Instituto de Ciencia Animal (ICA) from the Republic of Cuba began to develop between 1967 and 2014, with an emphasis on genetic improvement, use of food produced in Cuba, Physiology and the study of rabbit gastrointestinal tract. For more than 40 years, ICA has been an adviser in studies of genetic improvement in Cuba, and has recommended the use of different forages containing between 14 and 32 % of crude protein, as well as some other food of national production, which are used by an important amount of medium and small producers of rabbits, with positive results. The institute also selected a system of equations for estimating digestible energy of food destined to rabbits. ICA also designed a program that formulates rations destined to rabbits, with all types of food. During this period, the institute participated on the training of rabbit producers and the graduation of six PhD students of Veterinary Sciences and seven Masters in Science. During this period, a manual on rabbit rearing and a book about their feeding were written.

Key words: *rabbits, feeding, management*

INTRODUCTION

Rabbit researches at the Instituto de Ciencia Animal (ICA) from the Republic of Cuba began in 1967, in the facilities of the institute, very close to Zaragoza town. Back then, a group of young researches, including Raquel Ponce de León, Miriam Ribas, Carmen Rico and Francisco Diéguez, and led by Marcon B Willis, PhD, started their studies on rabbit genetics (ICA 1973 and ICA 1985).

In 1972, a poultry unit of ICA was remodeled to carry out researches on rabbit feeding and nutrition. Raquel Ponce de León, Rolando Romero and Rena Pérez (ICA 1973 and ICA 1985) worked in this facility.

After 1974, the institute decided to reduce researches on rabbits and those facilities were dismantled. Then, the researches were oriented towards rabbit genetic improvements, which were developed in the facilities of "Empresa Cunícola de La Habana" and those of the "Empresa de Especies Menores" from Santiago de Cuba. After that, the institute assumed the advising of the National Program of Rabbit Genetic Improvement in Cuba, in which Raquel Ponce de León, PhD (ICA1975 and ICA 1985) had an important role.

During the 90´s and at the beginning of 2000, researches were carried out in two small rabbit units, temporarily equipped for this purpose at ICA, after the studies on rabbit feeding and nutrition were retaken, with the use of alternative feeds of national production (Ponce de León and Larduet 1999 and Ponce de León *et al.* 1999). During this stage, there were also researches on bio-physiology of the gastrointestinal tract (Dihigo *et al.* 2001, Dihigo 2004 and Dihigo *et al.* 2004).

From September 2014, studies on rabbit feeding and nutrition were carried out in other two small units, with 80 female reproducers and capacity for their offsprings. These facilities were located at Finca Guayabal, which is an area of research, training and production that belongs to the ICA.

NUTRITION, FEEDING AND DIGESTIVE PHYSIOLOGY OF RABBITS

Between 1967 and 1985, researchers determined that the use of between 14 and 16 % of crude protein in feedstuffs destined to fattening rabbits, plus the supplementation of high quality fresh forage, like ramie (*Boehmeria nivea*), allowed to sacrifice White Semi-Giant, California, New Zealand and Chichilla, after 91 days of age and between 2.0 and 2.2 kg of liveweight (Rico and Menchaca 1973). Researches also confirmed that the inclusion of 3% of zeolite on pelletized feedstuffs for feeding rabbits improved the quality of pellets.

Reproductive performance of does with diets containing between 17 and 20 % of crude protein was considered as excellent, and allowed to wean bunnies with 35 d after parturition (Ribas 1973 and ICA 1985).

In order to replace alfalfa meal included in diets for rabbits, which is imported at very high prices in the international market, ICA carried out studies on forages that have a satisfactory growth and reproduction in Cuba, and contain between 14 and 30 % of protein. These researches are sometimes performed with fresh forages, and, some other times, with their meals that are included on diets (table 1) used by small and medium producers of rabbits in Cuba.

Tabla 1. Fresh forages or their meals used on rations for rabbits at ICA or in joined studies with other institutions

Fresh forages or their meals (from 14 to 30 % CP)	Authors
Ramie (*Boehmeria nivea*)	Ponce de León (datos inéditos)
Teramnus (*Teramnus labialis*)	La O (2007) and La O and Valdivié (2008)
Hibiscus (*Hibiscus rosa*-sinensis)	La O (2007) and La O and Valdivié (2008)
Phyla nodiflora L	La O (2007) and La O and Valdivié (2008)
Sweet potato liana (*Ipomoea batata*)	La O (2007) and La O and Valdivié (2008)
Mulberry (*Morus alba*)	Dihigo (2007) and Dihigo *et al.* (2008)
Dolicho (*Lablab purpureus*)	Caro (2008) and Caro and Dihigo (2012)
Mucuna (*Stizolobium spp.*)	Caro (2008) and Caro and Dihigo (2012)
Moringa (*Moringa oleifera*)	Diz (2013) and Caro(2014)
Bread tree leaves (*Artocarpus altilis*)	Leyva and Valdivié (2007) and Leyva (2010)
Tithonia (*Thitonia diversifolia*)	Fernández *et al.* (2012)
Elephant grass (9 % PB)	Pérez and San Sebastián (1970)

Other national foods were evaluated as cereals substitutes. Soybean meal, lipid sources, crude protein and fiber favored the obtaining of good results, which were generalized by small producers of rabbits in Cuba. There were also studies on distillery grains from maize, which were dried and mixed with solubles. These grains are internationally known as DDGS and as Norgold in Cuba (table 2).

Díaz (2005), with the assistance of Raquel Ponce de León, designed a system with several equations, for estimating digestible energy in conventional and nonconventional foods. This system came along with a table with energy contributions of an increased amount of all kinds of foods for rabbits, which are used by feedstuff formulators.

Another important study was developed by Ponce de León and Larduet (1999), which was a program called ALIMCONEJOS that allowed ration formulation for rabbits with different alternative or traditional foods available in Cuba and other countries from tropical and subtropical areas.

Tabla 2. Food produced at the ICA for feeding rabbits

Food	Authors
Citric pulp	Ponce de León *et al.* (1999a) and Dihigo (2007)
Saccharina	Ponce de León *et al.* (2002a)
Sugar cane meal	Dihigo *et al.* (2001) and Dihigo (2007)
Sugar cane stem	La O (2007) and Valdivié *et al.* (2009)
Root of chopped and cooked cassava	Valdivié *et al.* (2008)
Meal of cassava roots without peel	Mora *et al.* (2014)
Sunflower seed	La O (2007)
Water-forage of *Leucaena leucocephala*	López (2009), López *et al.* (2012a) and López *et al.* (2012b)
Bread tree meal	Leyva (2010), Leyva and Valdivié (2007) and Valdivié and Bicudo. (2011)
DDGS	Vázquez *et al.* (2011), Vázquez *et al.* (2013) and Vázquez (2014)

RABBIT GENETICS

Most of the genetic studies on rabbits at ICA have been carried out by Raquel Ponce de León, PhD, from 1967 up to this moment (Ponce de León 1977, Ponce de León and Menchaca 1985, Ponce de León *et al.* 1999b, 2001, 2002b, 2002c, 2003a, 2003b, 2004). After 2003, Yoleisy García, PhD., joins this research field (García 2005, García *et al.* 2008, García *et al.* 2010, García *et al.* 2011, García *et al.* 2012 and García 2014). It is important to highlight the advice given by the institute to farms belonging to rabbit program in Cuba, which work on genetic improvements, technically designed by Raquel Ponce de León, PhD.

The main studies on genetic improvement were performed with pure breeds and their lines, rotational crossings, gene pool, and some other methods of genetic improvement, with the application of genetic and non-genetic indicators. Breeds used were White Semigiant, California, Chinchilla and New Zealand (ICA 1973, ICA

1975, Ponce de León 1977, ICA 1985 and García 2014), and new synthetic rabbit breed Caoba (Ponce de León *et al.* 1999b, 2001).

The studies on rabbit genetic improvement carried out at the institute are published in a review article of this same volume of the Cuban Journal of Agricultural Science.

TRAINING OF DOCTORS AND MASTERS IN VETERINARY SCIENCES

The Instituto de Ciencia Animal has contributed to the training of six PhD in Veterinary Sciences for the work with rabbits in Cuba, a Doctor in Sciences and seven Master in Sciences, which represent the highest number of students trained for this purposes. This training has had national and international recognition in the field of genetics, feeding and digestive physiology of rabbits.

These highly qualified specialists work as teachers, researchers and producers at the Instituto de Ciencia Animal and at universities like Granma University, University of Havana and Guantánamo University, as well as at enterprises like Empresa de Ganado Menor de Cuba (EGAME).

The institute also published two books related to rabbits: "Manejo y explotación del conejo", written by Riverón *et al*. (2003), edited by the Cuban Association of Animal Production (ACPA, initials in Spanish), and "Alimentación de aves, cerdos y Conejos", written by Valdivié and Bernal (2012), and edited by the editorial from Universidad Autónoma de Nuevo León in Mexico.

DEPARTMENTS OF THE ICA RELATED TO RABBIT REARING

There are four research departments at ICA that combine their work with rabbit researches: Department of Genetics, which started and has been developing the highest amount of researches on rabbits; the Department of Feeding and Management of Non-ruminant Animals, which has the responsibility of feeding rabbits and, to a lesser extent, to manage them; and the Department of Bio-physiological Sciences, which has characterized the nutritional value of most of the food produced at the ICA, and has developed studies on the physiology of the gastrointestinal tract of rabbits. The fourth department is the Department of Engineering, which has also worked on the building of an equipment for pressing rabbit food (miniblocks)

CONCLUSIONS

Rabbit researches at Instituto de Ciencia Animal has allowed to advise the genetic imrpovement in Cuba for more than 40 years. Thanks to the work of the institute, several forages have been used, which contain between 14 and 32 % of crude protein, as well as other foods of national production that are used by an important amount of medium and small producers of rabbits, with positive results.

ICA produced a system of equations for estimating digestible energy of food destined to rabbits and a system for formulating rations with all types of foods

Between 1967 and 2015, the institute has also participated in the training of rabbit producers, six PhDs in Veterinary Sciences and seven Masters in Sciences, which work with rabbits in Cuba.

REFERENCES

Caro, Y. 2008. Estudio del efecto de dietas de harinas integrales de follajes de leguminosas temporales (*Lablab purpureus* y *Stizolobium niveum*) en indicadores nutricionales y morfofisiológicos del conejo. Trabajo de Diploma .Universidad Agraria de La Habana. San José de las Lajas. 53 p.

Caro, Y. 2014. Uso de la harina de forraje de moringa (*Moringa oleiera* var. Supergenius) en la alimentación de conejos de ceba Nueva Zelanda Blanco. Tesis de Maestría. Mayabeque, Cuba. 54p

Caro, Y. & Dihigo, L.E. 2012. Comportamiento productivo de conejos alimentados con dietas que incluían harina integral de dólico y mucuna. Rev. Unell. Cienc. Tec. 30: 29

Diaz, O. 2005. Estimación de energía digestible en alimentos convencionales y no convencionales para el conejo. Tesis de Maestría. Instituto de Ciencia Animal. La Habana, Cuba. 107 pp.

Dihigo, L.E. 2004. Effect of the roughage source for rabbits and the incubation time on in vitro dry matter digestibility. Cuban J. Agric. Sci. 38:179

Dihigo, L.E. 2007. Caracterización físico-química de productos tropicales y su impacto en la morfofisiología digestiva del conejo. Tesis Dr. Instituto de Ciencia Animal, La Habana, Cuba

Dihigo, L.E., Savón, L., Hernández, Y., Domínguez, M. & Martínez, M. 2008. Physicochemical characterization of mulberry (*Morus alba*), citrus (*Citrus sinensis*) pulp, and sugarcane (*Saccharum officinarum*) meals for the feeding of rabbits. Cuban J. Agric. Sci. 42: 65

Dihigo, L.E., Savón, L. & Rosabal, Y. 2004. Determination of

the in vitro digestibility of dry matter and neutral detergent fiber in five forage plants using the rabbit cecal inoculums. Cuban j. Agric. Sci. 38:287

Dihigo, L.E., Savón, L. & Sierra, F. 2001. Morphometric studies of the gastrointestinal tract and internal organs of rabbits consuming sugarcane meals. Cuban J. Agric. Sci. 35: 337

Diz, R. 2013 Comportamiento productivo de conejos que consumen harina de forraje de *Moringa oleiera*. Tesis de Maestría. Instituto de Ciencia Animal. Mayabeque, Cuba. 70 pp.

Fernández, M., Fernández, M.Jr., Valdivié, M. & Bicudo, S.J. 2012 Nuevo sistema alternativo y semintensivo de producción de conejos. Revista ACPA. No. 1. p. 40

García, Y. 2005. Fuentes de variación genética en cruces simples y a cuatro vías de conejos. Tesis de maestría. Instituto de Ciencia Animal. La Habana, Cuba. 83 p.

García, Y. 2014. Mérito genético de cruces dialélicos y reproductoras F1 como líneas maternas cunículas. Tesis Dr. ICA, Cuba.118 p.

García, Y., Ponce de León, R. E. & Guzmán, G.S. 2008. Genetic variation sources influencing fertility and birth traits in F1 rabbits. Cuban J. Agric. Sci. 42:343

García, Y., Ponce de León, R. & Guzmán, G. 2010. Differences between two-way crosses and heterosis for total and live births in complete diallelic crossbreeding of five rabbit breeds. Cuban J. Agric. Sci. 44:113

García, Y., Ponce de León, R. & Guzmán, G. 2012. Racial and heterosis effects of prolificacy traits on complete diallelic crossings between four rabbit breeds. Cuban J. Agric. Sci. 46:139

García, Y., Ponce de León, R., Mastache, A. A. & Guzmán, G. 2011. Genetic components of the traits of prolificacy and mortality at birth in a diallel cross between five rabbit breeds. Cuban J. Agric. Sci.45:15

ICA 1973. Instituto de Ciencia Animal: Technical Report 1971-1972. Impresora Andre Voisin del Ministerio de Educación Superior. La Habana. Cuba. 157 pp.

ICA 1975. Instituto de Ciencia Animal: Technical Report 1973-1974. Impresora Andre Voisin. Ministerio de Educación Superior. La Habana. Cuba. 145 pp.

ICA 1985. Dos décadas de investigación. Instituto de Ciencia Animal. Impresora Andre Voisin. Ministerio de Educación Superior. La Habana. Cuba. 193 pp.

La O, A.L. 2007. Alimentación de conejos (*Oryctogalus cuniculus*) con follajes, caña de azúcar y semillas de girasol. Tesis Dr. Instituto de Ciencia Animal. La Habana, Cuba. 142 pp.

La O., A.L. & Valdivié, M. 2008. Follajes de boniato, mar pacífico, teramnus y oro azul en la alimentación de conejos. Revista ACPA No. 1. p. 17

Leyva, C. 2010. Caracterización química de harinas de frutos y de hojas del árbol del Pan (*Artocarpus altilis*) y su empleo en la alimentación de pollos, conejos y ovinos de ceba. Tesis Dr. Instituto de Ciencia Animal. La Habana, Cuba.

Leyva, C. & Valdivié, M. 2007. Fruta del pan y la alimentación en animales de Traspatio. Revista ACPA. No 1. p. 48

López, B. 2009. Producción y empleo del hidroforraje de *Leucaena leucocephala* para la alimentación de conejos. Tesis Dr. Univ. Granma. Bayamo. Cuba.

López, B., Cisneros, L. M., Valdivié, M., Sotto, V., Ramírez de la Ribera, J., Savón, L. & Sosa, W. 2012b. Nutritive values indicators of the *Leucaena leucocepahla* hydroforage for rabbit feeding. REDVET. Rev. Electrónica de Veterinaria. Vol. 13. 2

López, B., Cisneros, M., Valdivié, M., Soto, V. & Savón, L. 2012a. Hidroforraje de *Leucaena leucocephala* para alimentar conejos. Rev. Prod. Anim. 24:1

Mora, L.M., Moura, A.S, Scapinello, C., Bicudo, S.J, Araujo, I.G., Curcelli, F. & Barros, T.F.M. 2014. Digestible energy of unpeeled cassava root meal and its effect on growth performance and carcass traits in rabbits. World Rabbit Sci. 22: 105

Ponce de León, R. 1977. Fuentes genéticas de variación y heterosis de los caracteres maternos en cruces simples, triples y de 4 razas en conejos. Tesis Dr. ICA, La habana

Ponce de León, R., Elías, A & Guzmán. G. 2002a. Evaluación de harinas de caña enriquecidas en dietas no convencionales de conejos. II Congreso de Cunicultura de las Américas. La Habana. Cuba. p.137

Ponce de León, R., Guzmán, G. & León, I. 1999a. Citrus meal in pelleted diets for fattening rabbits. Cuban J. Agric. Sci. 33:157

Ponce de León, R., Guzmán, G., Pubillones, O., González, J. & Mora, M. 2003a. Reproductive and pre-weaning performance of purebred imported rabbits. Cuban J. Agric. Sci. 37:349

Ponce de León, R., Guzmán, G., Pubillones, O., González, J., Mora, M. & Quesada, M. E. 2004. Genetic parameters of growth traits in four rabbit breeds. Cuban J. Agric. Sci. 38:231

Ponce de León, R., Guzmán, G., Quesada, M.E., Mora, M. & Febles, M. 2003b. Comparative reproduction of purebred rabbits in commercial conditions. Cuban J. Agric. Sci. 37:339

Ponce de León, R., Guzmán, G., Quesada, M.E., Mora, M. & Febles, M. 2002b. Environmental effects on reproductive and pre-weaning performance of rabbit purebreds. Cuban J. Agric. Sci. 36:105

Ponce de León, R., Guzmán, G. & Quesada, M.E. 2002 c. Growth and feed efficiency of four rabbit breeds. Cuban. J. Agric. Sci. 36:7

Ponce de León, R., Guzmán, G., Tamayo, J. & Publillons, O. 2001. The new synthetic rabbit breed Caoba. Environmental and genetic effects on growth traits. Cuban J. Agric. Sci. 35:107

Ponce de León, R. Guzmán, G. Tamayo, J. & Publillons, O. 1999b. La nueva raza sintética de conejos caoba. Efectos ambientales y genéticos en rasgos del crecimiento. Rev. Cubana Cienc. Agric. 35: 113

Ponce de León, R. & Larduet, R. 1999. Programa de fórmulación de raciones "ALIMCONEJOS". Versión 1.0. Manual del Usuario. Copyright Ciensoft. Instituto de Ciencia Animal

Ponce de León, R. & Menchaca, M. 1985. Efectos raciales y heterosis en rasgos reproductivos en cruces simples entre cuatro razas. Rev. Cub. Cienc. Vet. 16: 97

Pérez, R. & San Sebastián, J.R. 1970. Dehydrated elephant grass meal in integral diets and supplementary fresh forage fed to growing rabbits. Cuban. J. Agric. Sci. 4:207

Ribas, M. 1973. A comparison of two weaning system and two parturitions in Semi-Giant rabbits. Cuban. J. Agric. Sci. 7:17

Rico, C. & Menchaca, M. 1973. Studies on genotype-environment interaction and optimum protein level in rabbit diets. Cuban. J. Agric. Sci. 7:9

Riverón, S.H., Ponce de León, R., Reinaldo, L., Clavijo, A. &Clavijo, Y. 2003. Manejo y explotación del conejo. Cuba. ACPA. 175 pp.

Valdivié, M. & Bernal, H. 2012. Alimentación de aves, cerdos y conejos con yuca y otros alimentos alternativos. Ed. UANL. México 230 pp.

Valdivié, M. & Bicudo, S. J. 2011. Alimentacào de animais monogástricos. Livro Ed. FEPAU. Botucatu, S. F. Brasil, 307 p.

Valdivié, M., Mora, L.M. & La, O.A.L. 2009. Alimentación de cerdos, aves y conejos con tallo de caña. Revista ACPA. No 3. p. 53

Valdivié, M., Rodríguez, B. & Bernal, H. 2008. Alimentación de aves, cerdos y conejos con raíz de yuca (*Manihot sculenta* crantz) Revista ACPA. No.2. p. 45

Vázquez, Y. 2014. Evaluación de la utilización de los granos de destilería secos con solubles (DDGS) en conejo en ceba. Tesis de Maestría. Instituto de Ciencia Animal. Mayabeque, Cuba. 84 pp.

Vázquez , Y., Bernal, H., Valdivié, M., Gutiérrez, E., Castellanos, L.M., Hernández, C. A., Juárez, A. & Cerrillo, M.A. 2013.Use of dehydrated distillery grains with solubles in diets for fatteningrabbits. Cuban J. Agric. Sci. 47:45

Vazquez, Y., Valdivié, M. & Mora, L. 2011. Norgold: alimentación de equinos y ceba de conejos. Revista ACPA. No 2. p. 23

Received: September 30, 2014