World
Rabbit
Science
Association

PROCEEDINGS OF THE 12th WORLD RABBIT CONGRESS

Nantes (France) - November 3-5, 2021

ISSN 2308-1910

This communication was accepted by the scientific committee of the Congress

but was not presented during the Congress itself,
neither face-to-face nor remotely via Internet.

RABBIT MEAT (*ORYCTOLAGUS CUNICULUS* L.) ENRICHED IN OMEGA-3 BY A DIET CONTAINING EUPHORBIA (*EUPHORBIA HETEROPHYLLA* L.)

Kouakou D.[1*], Angbo-Kouakou E. [1,2], Ahongo D.[1,3], Assidjo E.[1]

[1]Institut National Polytechnique Félix Houphouët-Boigny (INP-HB), B.P. 1093 Yamoussoukro, Côte d'Ivoire
[2]CIRAD, UMR INNOVATION, F-34398 Montpellier, France
[3]INNOVATION, Univ Montpellier, CIRAD, INRA, Montpellier SupAgro, Montpellier, France
[*]Corresponding author: david.kouakou@inphb.ci

ABSTRACT

Euphorbia heterophylla is a weed whose leaves and stems can constitute 70% of rabbit diet. Furthermore, the α-linolenic acid content (ALA, C18:3 n-3) of this weed is closely comparable to that of flax (*Linum usitatissimum*). To contribute to a better nutritional balance of people, the effect of dietary supplement over a duration of diet test based on rabbit pellet (MOD0) with leaves and stems of this weed on the linoleic (LA, C18:2 n-6) and ALA fatty acids content of *Semimembranosus*, *Longissimus dorsi* muscles and perirenal fat of local breed male rabbits (*Oryctolagus cuniculus*) was investigated. The test diet (MOD0) was supplemented by 50% of dry matter of euphorbia during the three months growth of rabbits (MOD90) or by 50% of euphorbia dry matter for only month between the 61st and 91st days (MOD30). LA/ALA PUFA ratios were 9.8, 2.1 and 1.5 in *Semimembranosus*, 11.8, 4.6 and 2.1 in *Longissimus dorsi* and 8.6, 2.0 and 1.0 in perirenal adipose tissue respectively for MOD0, MOD30 and MOD90 ($P<0.001$). The supplement duration at least 30 days of euphorbia, had positive impact on *LA/ALA PUFA* ratios which are compliant to international recommendation (equal to or inferior to 5) for human nutrition. In conclusion, good supplementation of rabbit diet by euphorbia in regions where it abounds will be beneficial to human health.

Key words: Rabbits, *Euphorbia heterophylla*, omega 3 fatty acids, meat quality.

INTRODUCTION

Present in Africa and Asia, the leaves and seeds of *Euphorbia heterophylla* have an α-linolenic acid (ALA) profile close to that of flax (*Linum usitatissimum*) (Earle *et al*., 1960). Additionally, the leaves are used to improve the n-3 polyunsaturated fatty acid (PUFA) profile of guinea pig meat (Kouakou *et al.*, 2013), while adding of seeds into the laying quail diet improves the profile of egg yolk (Kouakou *et al*., 2018).
Highly ingested by rabbits where this fodder can constitute 50 to 70% of the dietary intake of dry matter (Kouakou *et al*., 2016a, Kouakou *et al*., 2016b), this plant could equally improve PUFA n-3 profile of rabbit meat. The objective of the study is to determine the effect of dietary supplement duration of diet test based on rabbit pellet with leaves and stems of the PUFA levels of the *Semimembranosus*, *Longissimus dorsi* muscles and the perirenal adipose tissue of local rabbits growing due to the positive correlation between the quality of dietary lipids and the muscle lipid profiles of rabbits (Kouba *et al*., 2008).

MATERIALS AND METHODS

Animals and experimental design

A total of 45 rabbits (*Oryctolagus cuniculus*) from a local Ivorian village were bred in cages with 35 dm^3 per animal of the experimental farm at the ***Institut National Polytechnique Félix Houphouët-Boigny***, Yamoussoukro (Côte d'Ivoire) and subjected to dietary treatments: control group (MOD0)

received a diet composed of a commercial rabbit pellet (SIPRA-IVOGRAIN, Abidjan, Côte d'Ivoire) and guinea grass (MOD0) during the whole period lasting 91 days, while first treated group (MOD90) was fed a diet composed of rabbit pellet and guinea grass (MOD0) by adding 50% of leaves and stems of *Euphorbia heterophylla* during the three-month life of the rabbits, and the second treated group (MOD30) received the same diet (MOD90) but only during the final 30 days of fattening (between the 61st and 91st days) (Table 1). At 91 days, ten animals weighing at slaughter 2.2±0.2, 1.8±0.1 and 1.7±0.1 kg respectively for each experimental group (MOD0, MOD30 and MOD90) were slaughtered and samples of *Semimembranosus*, *Longissimus dorsi* muscles and perirenal fat were dissected from the carcass.

Chemical Analyses

Lipids were extracted from samples of *Semimembranosus*, *Longissimus dorsi* muscles, perirenal fat and diets, using the procedure of Delsal (1944) at the Laboratory of Biochemistry and Human Nutrition of the west Agrocampus Ouest at Rennes (France). Fatty acid methyl esters (FAME) were prepared with boron trifluoride-methanol according to Morrison and Smith (1964), and analyzed on an Agilent Technologies 6890 N gas chromatograph (Bios Analytic, Toulouse, France). Identification of FAME was based on retention times obtained for FAME prepared from FA standards.

Statistical Analysis

Differences between treatments were examined with one-way ANOVA using Stata Corp (2011). Least square means were obtained using Student-Newman-Keuls test and the significance level was calculated at 5 per cent confidence level.

RESULTS AND DISCUSSION

The chemical composition and fatty acid profile of forages and rabbit pellet are presented in Table 1, while feed intake (g of DM /rabbit/day) during the test are presented in table 2. Findings reported in table 2 confirm that spurge is highly ingested by rabbits where it constitutes 50% of the dietary intake of dry matter. The best intake of spurge and rabbit pellet compared to Guinea grass could be explained by their lower fibre content and by the digestive physiology of the rabbit (Kouakou *et al*., 2016b).

Total n-3 PUFA levels in *Semimembranosus*, *Longissimus dorsi*muscles, and adipose tissue were significantly higher in samples of rabbit supplemented by spurge, with a significant increase in ALA contents (Table 3). These results can be explained by ALA contents in the diets and their intake duration. Indeed, the more diets are rich in n-3 PUFA, the more rabbit tissues will be enriched in PUFA n-3, because in the latter, food-based fatty acids are directly incorporated into intramuscular lipids (Gigaud and Combes, 2007, Dalle Zotte *et al*., 2016). DPA is preferentially incorporated in the phospholipids, which are found in a higher proportion in *Longissimus dorsi* than in *Semimembranosus*. In contrast, ALA is preferentially incorporated in triacylglycerol fraction, which is found in greater amounts in *Semimembranosus* compared to *Longissimus dorsi* (Peiretti and Meineri, 2008).

The LA/ALA ratio of the different samples of rabbits supplemented with spurge were significantly lower ($P<0.00001$). These results suggest that the increased ALA and generally n-3 PUFA content promotes a balanced use of Δ-6 desaturase for the metabolism of n-6 and n-3 PUFAs (Ander *et al*., 2010).

The LA/ALA fatty acid ratio of the *Semimembranosus* and *Longissimus dorsi* muscles of the control rabbits (MOD0) is similar to that of the carcass and *Longissimus dorsi* muscle of rabbits traditionally fed by Combes (2004). In addition, the LA/ALA ratios obtained in the MOD30 and MOD90 samples were in line with international recommendations (equal to or less than 5) (Gigaud and Combes, 2007).

Table 1: Chemical composition and fatty acid profile of forages and rabbit pellet

Chemical composition (%DM)	*E. heterophylla*	Rabbit pellet	*P. maximum*
Dry matter (%)	20.3	88.7	26.9
Proteins (%DM)	16.5	13	9.7
Cellulose (%DM)	22.4	14.6	32.1
Fat (%DM)	7.2	3.3	2.5
Fatty acid composition (%of total fatty acids)			
SFA	22.6	40.6	25.4
C12:0	0.1	14.5	0.1
C14:0	0.4	5.4	0.2
C16:0	19.6	18.8	22.5
C18:0	2.5	1.9	2.6
MUFA	3.6	20.4	22.6
C16:1 n-7	0.4	-	0.5
C16:1 n-9	0.9	0.1	1.8
C18:1 n-7	1.0	1.1	0.1
C18:1 n-9	2.2	19.2	20.2
PUFA	67.2	37.9	48.4
C18:2 n-6	10.7	36.0	21.4
C18:3 n-3	56.5	2.0	27.0
C18:2 n-6/C18:3 n-3	0.2	18.1	0.8

SFA: Saturated Fatty Acids; **MUFA:** Monounsaturated Fatty Acids; **PUFA:** Polyunsaturated Fatty Acids.

Table 2: Feed intake (g of DM /rabbit/day) during the test

		Supplementation duration		
		MOD0	**MOD30**	**MOD90**
Lactation	Intake	237±11**a**		194±17**b**
	P. maximum	51±4**a**		40±4**b**
	Rabbit pellet	186±9**a**		44±0**b**
	E. heterophylla	-		110±21
Growth	Intake	102±10**a**		79±18**b**
	P. maximum	17±4**a**		15±3**a**
	Rabbit pellet	85±1**a**		27±4**b**
	E. heterophylla	-		38±14
Fattening	Intake	128±18**a**	133±13**a**	131±27**a**
	P. maximum	19±5**a**	18±5**a**	16±6**a**
	Rabbit pellet	109±19**a**	44±0**b**	44±0**b**
	E. heterophylla	-	70±10**a**	71±22**a**

Means±sd
a, b, c:Means with different letters on the same row differ significantly (Student-Newman-Keuls test).

Table 3: Fatty acids content of *Semimembranosus*, *Longissimus dorsi* muscles and perirenal fat of local rabbit fed with test diet (MOD0) supplemented by 50% of leaves and stems of *E. heterophylla* for a period of one month (MOD2) or three months (MOD1)

	MOD0	**MOD30**	**MOD90**	***Effet mode***
Semimembranosus				
SFA	42.6±0.8ab	40.6±1.2a	44.4±1.9b	*0.045*
MUFA	33.0±1.5a	26.9±2.2b	22.9±2.2b	*0.002*
PUFA n-6	22.0±1.6a	22.2±2.1a	18.9±1.6a	*0.110*
PUFA n-3	2.4±0.2a	10.4±1.2b	13.8±2.7b	*0.001*
PUFA n-6/PUFA n-3	9.4±0.2a	2.1±0.1b	1.4±0.2c	*0.001*
C18:2 n-6/ C18:3 n-3	9.8±0.2a	2.1±0.1b	1.5±0.1c	*0.001*
Longissimus dorsi				
SFA	41.6±3.1a	42.9±4.2a	42.1±1.2a	*0.881*
MUFA	29.7±2.7a	22.9±2.9b	19.4±1.6b	*0.006*
PUFAn-6	26.3±4.6a	27.7±2.5a	25.1±2.1a	*0.646*
PUFAn-3	2.4±0.8a	6.5±1.5b	13.4±1.0c	*0.001*
PUFAn-6/PUFAn-3	11.7±2.7a	4.4±0.9b	1.9±0.3b	*0.001*
C18:2 n-6/ C18:3 n-3	11.8±2.1a	4.6±1.1b	2.1±0.4b	*0.001*
Perirenal fat				
SFA	46.0±1.2a	35.5±2.3b	34.0±2.0b	*0.001*
MUFA	27.4±0.7a	24.1±1.9b	19.4±1.1c	*0.001*
PUFA n-6	22.3±0.9a	25.8±1.5b	22.4±1.0a	*0.018*
PUFA n-3	2.8±0.3a	13.3±0.4b	23.1±2.7c	*0.001*
PUFA n-6/PUFA n-3	8.0±0.5a	2.0±0.1b	1.0±0.1c	*0.001*
C18:2 n-6/ C18:3 n-3	8.6±0.2a	2.0±0.1b	1.0±0.1c	*0.001*

Means ± sd;
a, b, c:Means with different letters on the same row differ significantly (Student-Newman-Keuls test);

CONCLUSIONS

The dietary supplement of the conventional rabbit feed consisting of granulated commercial feed and guinea grass with an equivalent of leaves and stems of the spurge in local rabbits for only 30 days (between the 61st and 91st days or for 91st day, is a simple way to obtain meat with LA/ALA ratio of 5 according to international recommendations. Also, given the deficit of this nutrient in the diet in low- and middle-income countries, the two types of dietry supplement studied are to be popularized.

ACKNOWLEDGEMENTS

The authors thank Prof. Philippe Legrand and Dr. Daniel Catheline of the Laboratory of Biochemistry-Human Nutrition of Agrocampus Ouest of Rennes for their kind contributions.

REFERENCES

Ander B.P., Edel A.L., McCullough R., Rodriguez-Leyva D., Rampersad P., Gilchrist J.S.C., Lukas A., Pierce G.N., 2010. Distribution of omega-3 fatty acids in tissues of rabbits fed a flaxseed-supplemented diet. *Metabolism, 59 (5): 620-627.*

Combes S., 2004. Valeur nutritionnelle de la viande de lapin. *INRA Prod. Anim., 17 (5): 373-383.*

Dalle Zotte A., Cullere M., Alberghini L., Catellani P., Paci G., 2016. Proximate composition, fatty acid profle, and heme iron and cholesterol content of rabbit meat as afected by sire breed, season, parity order, and gender in an organic production system. *Czech J. Anim. Sci.*, 61 (9): 383-390.

Delsal L., 1944. A new procedure for extraction of serum lipids with methylal. Application to microdetermination of total cholesterol, phosphoaminolipids and proteins. *Bull. Soc. Chim. Biol., 26: 99-105.*

Earle F.R., Mcguire T.A., Mallan L., Bagby M.O., Wolff I.A., 1960. Search for new industrial oils. II. Oils with high iodine values. *J. Am. OilChem. Soc., 37 : 48-51.*

Gigaud V., Combes S., 2007. Effet d'un rapport décroissant oméga 6/oméga 3 du régime sur la teneur en acides gras de la viande de lapin et contribution de la viande ainsi produite aux apports nutritionnels conseillés. *In 12èmes Journées de la Recherche Cunicole. 27-28 novembre 2007, Le Mans, France, 191-194.*

Kouakou N.D.V., Coulibaly S.B.M., Angbo C.E.M., Thys E., Assidjo N.E., Kouba, M., 2016a. Réduction des coûts alimentaires des lapins (*Oryctolaguscuniculus* L.) par la distribution de l'herbe de lait (*Euphorbiaheterophylla* (L.) Klotz. &Garcke) associée à l'herbe de Guinée (*Panicum maximum* Jacq.) Lam. en élevage semi-intensif. *J. Appl. Biosci., 99, 9373-9381.*

Kouakou N.D.V., Grongnet J.-F., Assidjo N.E., Thys E., Marnet P.-G., Catheline D., Legrand P., Kouba M., 2013. Effect of a supplementation of *Euphorbia heterophylla* on nutritional meat quality of Guinea pig (*Caviaporcellus L.*). *Meat Sci., 93 (4): 821-826.*

Kouakou N.D.V., Thys E., Kouba M., 2016b. Etude comparative de digestibilité *in vivo* de *Panicum maximum* associé à *Ipomoeabatatas* ou à *Euphorbiaheterophylla* chez le lapin (*Oryctolaguscuniculus*) et le cobaye (*Caviaporcellus*). *Tropicultura, 34 (2): 158-165.*

Kouakou N'G.D.V., Koffi K.F., Angbo-Kouakou C.E.M., Koné G.A., Kouassi G.F., Amoikon K.E., Kouba M., 2018. Enrichment of quail (*Coturnixcoturnix japonica*) egg yolks with omega-3 polyunsaturated fatty acids by euphorbia (*Euphorbia heterophylla*) seeds. *Rev. Elev. Med. Vet. Pays Trop*., **70** (3): 99-103.

Kouba M., Benatmane F., Blochet J.E., Mourot J., 2008. Effect of a linseed diet on lipid oxidation, fatty acid composition of muscle, perirenal fat, and raw and cooked rabbit meat. *Meat Sci., 80 (3): 829-834.*

Morrison W.R., Smith L.M., 1964. Preparation of fatty acid methyl esters and dimethylacetals from lipids with boron fluoride-methanol. *LipidsRes., 5 : 600-608.*

Peiretti P.G., Meineri G., 2008. Effects on growth performance, carcass characteristics, and the fat and meat fatty acid profile of rabbits fed diets with chia (*Salvia hispanica L.*) seed supplements. *MeatSci*., 80 (4): 1116-1121.

StataCorp (2011). Stata/IC 12.0 for windows. *Lakeway Drive College Station, TX, USA: StataCorp LP.*