FNE02-447: Determination of Omega-3 Fatty Acid in Pastured Raised Meat Rabbits

In society's push to become healthier, more and more people are concerned about where and how their food is raised. Farmers and growers are now being asked to evaluate the contents of what they grow and raise. Foods high in omega 3-fatty acids (alpha-linolenic acid) are being selected as choice dietary items. These have been shown to be higher in meat from animals that have been reared on pasture. We propose to show that meat rabbits raised on pasture vs. an in-house system are leaner, healthier, tastier and richer in important fatty acids and proteins essential for a good diet.

Rumbleway Farm is located in Conowingo, Maryland on 62 acres. In a move to make our farm more sustainable we have become a Maryland Department of Agriculture Certified Organic Farm. We are in our third year as a certified organic farm. On our farm we raise hay, beef cattle, goats, pastured poultry (chickens and turkeys), pastured rabbits, and ducks. We built an on-site processing area in 1999 and expanded this area in 2000. In 2002 we completely enclosed our existing processing area and added a separate kill room and a certified kitchen. The farm is now a USDA certified poultry processing facility and our kitchen is a certified food service facility. In 2001 we raised and processed 750 Cornish game hens, 125 white turkeys, and 150 rabbits. In 2002 we have raised and processed 1000 chickens, 200 turkeys and over 300 rabbits.

Mark and I have farmed part time for the last ten years and have raised pastured poultry for the last five years. I have been full time at the farm for 2 years now. We have a Kit-hen house where we raise baby chicks and our breeding rabbits. The Kit-hen house is divided into four sections, we raise baby chicks and turkeys in two sections and have housing for rabbits and laying hens in the other two. We currently have four male rabbits (bucks) and fourteen female rabbits (does) (New Zealand, Californian's, and crosses). We raise our rabbits in a multi-tiered house system with laying chickens below and out on pasture. We have three pastured rabbit pens (8'x 8' x 18" high) on our sward of 80% orchard grass and 10-20% alfalfa-clover mix.

Last summer we decided to undertake a large feed and growth study in collaboration with Dr. James McNitt of Southern University and raised over 150 rabbits on pasture from six weeks to processing with very low mortality. In last years study we learned that it takes approximately 83 days to raise indoor rabbits to a market size of 5 pounds, and 105 days for rabbits on pasture to reach the same size. The costs per animals for feed is as follows: $1.52 for outdoor rabbits, $1.73 for inside rabbits, and $2.02 for rabbits born inside and then raised on pasture. We learned a lot of valuable information from that study that we were able to pass on to other farmers.

There has recently been a push for healthier and less fatty meat sources. Rabbits offer a leaner, tastier, and healthier alternative to red meat, but rabbits are a difficult market to get into. People are unsure about the taste and healthy benefits of rabbit meat. We hope this study can help us educate the public about meat rabbits and open up this new and growing field for farmers in the Northeast - an excellent climate for rabbit production. Raising rabbits on pasture is a new and growing market. Rabbits can be raised on 1 acre or less and require very little start up costs. For the part time or full time farmer raising rabbits can add profits without much investment. Rabbits can be raised, bred and kindled outside in portable shelters, with no need for a permanent structure.

Our collaborator Dr. James McNitt of Southern University was a valuable asset in study design, result interpretation and in statistical analysis of the data. Dr Ivis Forrester-Anderson from Morgan State University was responsible for the taste test portion of the study. We had hoped to send our tissue samples for Omega-3 analysis to Cornell University but the details could not be worked out so the samples went to Ralston Purina Analytical Laboratories in Saint Louis, MO.

Materials and Methods

A trial was carried out in northeastern Maryland in the summer of 2002 using four does housed in outdoor, movable pens and eight housed in conventional, single deck, suspended, 36"x 30" x 18" (91 x 76 x 46 cm) (LWH), all wire cages inside a building. Before the trial, all the does (10 New Zealand White, 2 Californian crossbred) were housed in cages. They were randomly bred to a New Zealand White or a New Zealand White X Californian crossbred buck on March 15, 2002. On April 1 the pregnant does that had been randomly selected to be on pasture were moved to 4' x 4' x 18" (120 x 120 x 46 cm) (LWH) floorless pens on an established sward (80:20 orchard grass: alfalfa-clover) overlaid with chicken wire with 2" (50 mm) openings to prevent the rabbits from digging out. The wire was placed on the pasture early in the season to enable the grass to grow through. The pens were moved daily to provide fresh grazing. Both groups were fed the same commercial feed (Manna Pro-Double Duty Complete Rabbit Feed, Manna Pro Corporation, 707 Spirit 40 Park Drive, St. Louis, Mo. 63005) free choice in J-feeders mounted on the cages. Feed usage post weaning was recorded by treatment. .

The eight does that kindled in cages produced 57 kits and the four in the outdoor pens produced 34. Of these, 50 of the kits born indoors and 32 of those born outdoors were weaned. The groups of does were identified as being housed in indoor cages (In) or in outdoor pens (Out). Groups of fryers were identified by location of birth and finishing. After weaning, 48 of the fryers born in the indoor cages were randomly assigned to cages within the barn (In In) or to the outside pens (In Out). All fryers born in outdoor pens were randomly assigned to one of four outdoor pens (Out Out). The litters were weighed at birth and at 21 days. The kits were then identified with ear tags and weighed individually on day 34±1.2, day 42±1.2 (weaning), day 55±1.2, day 82±1.2 and day 104±1.2. The variation in weighing days was a result of the litters having been born over a four-day period. At day 104, the rabbits were processed on the farm and carcass and fat weights recorded. Although this age was known to be excessive for the In In groups, previous work had shown that this much time was required for the Out Out groups to finish so the later age was used to maintain statistical accuracy. Because of mortality, there were 23 In In carcasses, 21 In Out carcasses and 30 Out Out carcasses available for analyses.

Prior to slaughter, four rabbits from each treatment group were randomly selected from which samples were collected postmortem for submission to Ralston Analytical Laboratories (St. Louis, MO) for determination of the fatty acid profiles by gas chromatography. An additional three similarly sized rabbits were selected from each test pen (12 rabbits per treatment group) for taste panel evaluation. After processing, the whole carcasses were air chilled for 12 to 15 hours at 1.1°C.

For sensory analysis, the hindquarters and loins were manually deboned and the meat stored in plastic bags at -18°C for several days before transmission to Morgan State University in Baltimore where the carcasses were stored at -18°C until time of use. The de-boned carcasses were cut in serving size pieces and lightly seasoned with Greek seasoning. All flank meats were excluded from cooking. Taste testing was conducted on meats of animals from all three treatments. The meat was cooked, stir-fried, to an internal temperature of 80°C and evaluated by a sensory panel of 54 adults for color, flavor, odor/aroma, texture, tenderness, juiciness and overall acceptability. The 9-point Hedonic scale and a descriptive score card were used. For the Hedonic scale, 9 represented "like extremely" and 1 "dislike extremely".

For fatty acid analysis, the left loin muscle *(m. Longissimus dorsi)* was removed and stored in a 50 ml conical tube. The tubes were frozen at -18°C for three days after which they were shipped frozen to Ralston Analytical Laboratories. The lipids were extracted and saponified with alcoholic sodium hydroxide. The fatty acids were esterified in methanol with boron triflouride as a catalyst, taken up in heptane and injected on a gas chromatograph with a flame ionization detector. The percentages of individual fatty acid methyl esters were calculated from standards containing known concentrations of methyl esters of selected fatty acids. Total fat was calculated as the sum of all fatty acids expressed as triglycerides (AOAC 19; Hammarstand 1966; Shepard 1989).

The data for growth characteristics and fat analysis were analyzed using the General Linear Models Procedure of SAS with housing treatment as the independent variable.

Results and Discussion

<u>Production</u>

The numbers and performance of the rabbits before weaning are shown in Table 1. The four does in the outdoor pens produced 34 kits of which 32 were weaned. All those fryers were finished in the outdoor pens. From the 57 kits born in the cages, 50 were weaned. Twenty-three fryers from eight litters born in cages were finished in the cages and 21 were finished in outdoor pens. There were no weight differences at birth or at three weeks for litters from In or Out does.

Eighty of the kits weaned were placed on the trial. The weaning weights and numbers are shown in Table 2. Despite the lack of difference in litter weights at birth or three weeks, the individual fryers from the Out does were significantly lighter at weaning (day

42) than the fryers born in the cages. This may have been a result of differences in milk production of the does or to slower acceptance of grazing on the part of the kits born in the pens. Overall, the mortality was quite low with only 6 of 80 fryers (7.5%) dying between weaning and slaughter. There was no apparent treatment effect.

Fryers born and finished in the indoor cages (In In) had higher ($P<0.01$) growth rates, final weights, carcass weights and fat weights than the fryers born indoors and finished on pasture (In Out) or the fryers born and finished on pasture (Out Out) (Table 3). The dressing percentage and feed:gain ratio were numerically higher for the In In group. For all traits, the rabbits born indoors and finished outdoors were numerically intermediate between the In In and Out Out groups. The final weights and carcass weights of the In Out group were higher ($P<0.05$) than the Out Out group. Fat weights of the In Out group were also higher ($P<0.01$)

As shown in Figure 1, the In In group reached a peak of rate of gain of 36.9 g/d at 54 days after which the rate steadily declined. The In Out group reached a lower peak of 25.0 g/d at about the same age but the rate declined more slowly over the finishing period., The Out Out group did not reach their peak rate of gain (26.1 g/d) until about 82 days of age. It is apparent from this figure and the final fat weights shown in Table 3 that the In In and In Out groups grew more rapidly than the Out Out group and were ready for slaughter much earlier than the set age of 104 days used in this trial. Total post weaning feed usage for the In In, In Out and Out Out groups was 9.52, 4.90 and 4.44 kg/animal, respectively.

Sensory Evaluation

The carcasses of the In Out and Out Out animals had little or no visible fat compared to the In In animals which had some visible fat. The carcasses of the In In animals were pale pink, compared to the In Out and Out Out carcasses which were of a brighter, rosier pink. Color differences were negated upon cooking. Rabbits reared outdoors (Out Out) had the highest mean score for flavor ($7.52 \pm .18$) and overall acceptability ($7.76 \pm .13$) (Table 4). The Out Out and In Out meats were more tender ($7.54 \pm .18$ and $7.35 \pm .19$, respectively) than the In In meats ($7.24 \pm .19$). The In Out meat had the highest score for juiciness ($7.68 \pm .18$). There were no differences in the aroma/odor of the meats. The color of the cooked meat for all treatments was described generally as pleasingly brown. The In In meat was described as having a tough texture and a dry appearance.

Fat composition

The left *m. Longissimus dorsi* from the selected carcasses were analyzed for the total fat content, the saturated fatty acid (SFA) content, the monosaturated fatty acid content (MUFA) and for content of 42 individual fatty acids. From these values, the contents of polyunsaturated fatty acids (PUFA), total omega-3 fatty acids and total omega-6 fatty acids were calculated. Table 5 contains a summary of the 33 fatty acids which were measurable in the samples.

There were no significant differences among the treatments for total fatty acid, SFA or MUFA content (Table 6) although all three were lower for the Out Out than the In In rabbits. Rule et al. (2002) studied the *longissimus dorsi* muscles of feedlot and grassfed cattle and bison and found significant decreases in total fatty acids and increases in the SFA for grassfed bison. There were significant increases in the content of PUFA for both bison and cattle. French et al. (2000) found a reduction in the total SFA, and an increase in the PUFA/SFA ratio and the PUFA content of *longissimus* muscle in cattle fed a diet of 22 kg grass DM compared to a diet containing 8 kg concentrate and 1 kg hay. In the present study, the PUFA contents were lower ($P<.05$) for the Out Out and In Out rabbits than for the In In.

Conclusions

The highly significant increase in omega-3 fatty acids and the omega-3 to omega-6 ratio and the decrease in the fat content when rabbits were placed on pasture is an important finding in light of the fact that the omega-3 fatty acids are often deficient in human diets.

The taste test concluded that the rabbits raised exclusively on pasture, and finished on pasture were better tasting than those raised strictly indoors

There are some definite disadvantages to pasturing the rabbits including the need for covering the sward with wire to prevent digging, the necessity for daily moving of the pens and the slower growth seen with the pastured animals. Having does kindle in the outdoor pens further increases the necessary work. As a result, it appears that the In Out method of management may be optimal in terms of the labor involved and the positive effects on the meat produced.

Final Thoughts

Dissemination of the results will occur as follows. A fact sheet about the study and its results will be distributed through SARE, the local extension office, interested agricultural groups, and the Professional Meat Rabbit Association Newsletter. Our collaborators will publish this information in their professional scientific journals. We will continue to raise rabbits on pasture not only for the economical advantages but also for the added health benefits. Having animals out on pasture fits in with the overall attraction and sustainability of our farm.

Robin and Mark Way
Dr. James McNitt
January 2003

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Table 1. Numbers and preweaning performance of litters

Doe location	In	Out
Number of does (litters)	8	4
Number of kits born	34	57
Mean litter weight (g)	448±35	463±29
Mean 3 week wt (g)	2040±131	1895±165
Number of kits weaned	50	32

Table 2. Effect of doe housing system on kits selected for the three treatments (means ± s.e.)

Kit group	Out Out	In Out	In In
Weaning weight (g)	569.4±15.5 ^{A}	669.6±18.5 ^{B}	678.0±17.7 ^{B}
Number of fryers on trial	32	24	24
Died	2	3	1

Means in the same row with unlike superscripts differ (P<0.01)

Table 3. Effect of fryer housing system on postweaning performance and carcass characteristics of fryers (means±s.e.)

Variable	Out Out	In Out	In In
Number of fryers at 104 d	30	21	23
Growth rate (g/d)	22.7±0.5 ^{B}	23.4±0.6 ^{B}	28.0±0.6 ^{A}
Final weight (g)	2156±41 $^{B\,b}$	2307±49 $^{B\,a}$	2640±47 $^{A\,a}$
Carcass weight (g)	1096±25 $^{B\,b}$	1187±30 $^{B\,a}$	1 385±29 $^{A\,a}$
Fat weight (g)	0.9±0.9 ^{C}	5.4±1.0 ^{B}	15.4±1.0 ^{A}
Dressing %	50.8±0.7	51.6±0.8	52.4±0.8
Feed:gain ratio	2.8	2.9	4.8

Means in the same row with unlike superscripts differ (A, B P<.01; a, b P<.05)

Table 4. Sensory characteristics of rabbit meat (means ± s.e) based on a 9-point Hedonic Scale (9=like extremely to 1=dislike extremely)

Characteristics	Out Out	In Out	In In
Color	7.54 ± .13	7.52 ± .17	7.56 ± .15
Flavor	7.52 ± .18	7.37 ± .18	6.98 ± .23
Aroma	7.50 ± .15	7.56 ± .17	7.41 ± .15
Texture	7.46 ± .15	7.31 ± .16	7.17 ± .17
Tenderness	7.54 ± .18	7.35 ± .19	7.24 ± .19
Juiciness	7.59 ± .19	7.68 ± .18	7.55 ± .29
Overall Acceptability	7.76 ± .13	7.61 ± .17	7.24 ± .20

Table 5. Effects of housing treatment on fatty acid contents of m. *longisisimus dorsi* of fryer rabbits

Fatty acid	Fatty acid	P	Out Out	In Out	In In	S.E.
			%	%	%	
C12	Lauric	.5100	.000	.032	.038	.029
C13	Tridecanoic	.4053	.030	.000	.000	.0173
C14	Myristic	.1671	.832	.852	1.288	.173
C14:1	Myristoleic	.4053	.000	.000	.070	.040
C15	Pentadecanoic	.3110	.655	.592	.585	.033
C15:1	10-Pentadecanoic	.6212	.000	.025	.028	.021
C16	Palmitic	.5348	23.125	23.700	24.025	.556
C16:1	Palmitoleic	.1921	.898	.852	2.052	.482
C17	Margaric	.1565	.890	.785	.755	.047
C18	Stearic	.0245	9.880^{a}	9.680^{a}	8.528^{b}	.304
C18:1T	Elaidic	.4150	.970	.265	.140	.454
C18:1CO	Oleic	.1815	15.025	14.975	17.125	.852
C18:1CV	Vaccenic	.2310	1.405	1.545	1.550	.063
C18:1OT	Other cis isomers	.6978	.152	.158	.128	.026
C19	Nonadecanoic	.3852	.215	.180	.198	.017
C18:2	Trans isomers	.2558	.218	.068	.058	.071
C18:2L	Linoleic	.2891	22.800	24.450	25.075	.983
C20	Arachidic	.0149	$.218^{a}$	$.188^{a}$	$.155^{ab}$	.012
C18:3GL	Gamma linolenic	.4053	.000	.000	.030	.017
C20:1	Eicosenoic	.1015	$.138^{b}$	.105	.188	.024
C18:3L	Linolenic	.1489	3.650	2.818	2.505	.384
C21	Heneicosanoic	.4053	.062	.000	.000	.036
C20:2	Eicosadienoic	.3749	.148	.702	.300	.274
C22	Behenic	.4987	.260	.210	.152	.062
C20:3	Homo-Gamma-Linolenic	.9985	.668	.662	.662	.073
C22:1	Erucic	.4053	.030	.000	.000	.017
C20:3	Eicosatrienoic	.005	$.162^{A}$	$.110^{A}$	$.030^{B}$	.021
C20:4	Arachidonic	.4587	7.800	9.355	7.552	1.059
C24	Lignoceric	.7311	.195	.165	.155	.037
C20:5	Eicosapentaenoic (EPA)	.0189	$.648^{a}$	$.568^{a}$	$.282^{b}$	.076
C24:1	Nervoic	.4559	.060	.100	.035	.035
C22:5	Docosapentanoic	.0018	3.448^{A}	2.415^{B}	1.180^{C}	.036
C22:6	Docosahexanoic	.0003	$.648^{A}$	$.405^{B}$	$.180^{C}$	.049

Means in the same row with unlike superscripts differ (A, B, C $P<.01$; a, b $P<.05$)

Table 6. Summary of effects of housing treatment on fatty acid contents of m. *longisisimus dorsi* of fryer rabbits

Treatment	P	Out Out	In Out	In In	S.E.
		g/100g	g/100g	g/100g	
Saturated fatty acids (SFA)	.0827	.118	.142	.210	.026
Monounsaturated fatty acids (MUFA)	.0920	.060	.070	.131	.021
Polyunsaturated fatty acids (PUFA)	.0355	$.175^{a}$	$.200^{a}$	$.285^{b}$	.026
PUFA:FA	.6218	1.493	1.402	1.419	.069
Total fat	.0586	.352	.412	.625	.072
Total omega-3	.0001	8.556^{A}	6.316^{B}	4.207^{C}	.407
Total omega-6	.2271	31.416	35.169	33.589	1.423
Omega-6/omega-3	.0001	3.737^{A}	5.753^{B}	7.968^{C}	2.879

Means in the same row with unlike superscripts differ (A, B, C P<.01; a, b P<.05)