

# FAT COLOUR AND FUR COLOUR IN DIFFERENT VARIETIES OF RABBIT

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The fat colour of most adult animals used for food is generally white but occasionally yellow fat occurs among cattle, especially among Channel Island breeds, and it is not unknown in sheep, pigs and rabbits. Yellow fat also occurs widely in poultry. Yellow fat is disliked by butchers and poulterers owing to a strong public prejudice against it, and a preference for white fat. In cattle (Hammond, 1932) and poultry (Table Poultry Production, 1930) yellow pigment is largely associated with definite breeds. In rabbits coloured fat was observed in strains troubled with sterility (Hammond & Marshall, 1925), but this was later proved to be mere chance association.

It was shown by Pease (1928, 1930) that yellow fat in rabbits was hereditary and behaved as a simple Mendelian recessive to normal white fat, and that the colouring matter could only reach the tissues when the ration contained suitable colouring material such as green food. On a ration devoid of green food all the animals appeared with colourless fat, but later, when they were fed green food, both white and yellow fats were found, consistent with the genetical expectation. The chemistry of the pigment was investigated by Willimott (1928), who reported the colour to be due to xanthophyll, whereas carotene might have been expected. Subsequently this was reinvestigated by Bernheim (1928) who confirmed the presence of xanthophyll. Furthermore, he concluded that the white-fatted rabbit absorbs xanthophyll from its food, but that it is broken down by oxidation in the liver and so never reaches the body tissues.

The shade of colour in yellow-fatted rabbit carcasses varies greatly, ranging from pale, waxy yellow to deep orange. Hirzel (1935) found that animals placed on a poor ration which led to loss of condition tended to be of a deeper shade of yellow resulting from the fact that the animal then utilized fat for body maintenance without wholly resorbing the pigment. Another form of yellow fat, occurring in frozen carcasses, was investigated by Vickery (1932) and was found to be due to oxidation during storage.

In the genetical work on yellow fat Pease also found that in his stock there was complete association between white fat and white fur and pink eyes (albinism), suggesting linkage between yellow fat and albinism. This was confirmed by Castle (1933), who also reported that, in addition to the familiar albinistic series, the chocolate factor was also linked with yellow fat (Castle, 1925). The general expectation would be that yellow fat would be rare in the albinistic series (including chocolate). Castle (1936) also found indications of more frequent 'crossing-over' in females than in males. However, when studying the composition of the carcass King Wilson & Morris (1932) noted, in a group of twenty-four albinos, that eight had white fat, fifteen had yellow fat and one was doubtful. In every case the ether extract was yellow.

## FAT COLOUR AND COAT COLOUR

A large sample of 1102 rabbits, killed as 'pelters' for fur and meat production (Dudley & King Wilson, 1943) provided a varied selection of breeds and varieties divided up into

thirty-six groups in which records were kept of fat colour. These animals were fed on mixed diets of green food and roots, hay, oats and a mash mixture containing bran, ground oats, yellow maize and fish meal, excepting four groups which were grazed on the grass. A wild rabbit is included since this had also been kept on a mixed diet similar to other hatched animals and its fat was found to be yellow. This animal was used in a cross to tames (Black Beverens) with white fat and the first cross were all white fatted as expected, but when these first crosses were bred together the recessive yellow reappeared in the second

Table 1. *Sex, fat colour and fur colour*

Variety	White fat		Yellow fat		% yellow fat	
	Males	Females	Males	Females	Males	Females
Dutch	64	5	1	0	1.49	0
Tan	15	6	0	0	0	0
'Himalayan' and Rex	21	1	0	0	0	0
Havana	49	40	1	0	2.00	0
Agouti strain	31	3	0	1	0	25.00
Silver	7	11	0	0	0	0
Black	25	3	0	0	0	0
Lilac	32	20	0	0	0	0
Angora, coloured or Himalayan	10	—	0	—	0	—
Angora, albino	96	27	41	3	29.93	10.00
Chocolate	43	7	0	0	0	0
Havana Rex	35	5	1	0	2.78	0
Steel series	45	14	0	1	0	6.67
Black Rex	8	6	0	0	0	0
Lilac Rex	35	10	0	0	0	0
Agouti $F_2$	12	7	5	4	29.41	36.36
Chinchilla $F_2$	5	8	0	0	0	0
Castorrex $F_2$	5	7	0	0	0	0
Sable	8	1	0	0	0	0
Miscellaneous	15	4	0	0	0	0
Chinchilla	15	15	0	0	0	0
Chinchilla Rex $F_2$	7	5	0	0	0	0
Argente, Champagne	1	4	0	0	0	0
Beveren, coloured	9	23	0	0	0	0
Beveren, albino	1	—	1	—	50.00	—
Flemish	9	10	0	1	0	9.09
<i>First Crosses</i>						
Albino Angora × Albino Beveren	15	—	10	—	40.00	—
Albino Angora × Chinchilla	19	—	0	—	0	—
Albino Angora × Flemish	16	3	1	0	5.88	0
Lilac × Castorrex	16	13	4	0	20.00	0
Dutch × Flemish	10	—	0	—	0	—
<i>Feeding Groups</i>						
Grazed Dutch	19	—	1	—	5.00	—
Grazed Angoras (Albino)	10	2	3	1	23.08	33.33
Grazed Lilac and Rex	9	3	0	0	0	0
Grazed Black	13	—	0	—	0	—
Havanas, flaked	7	5	0	0	0	0
Havanas, kibbled	5	10	0	0	0	0
Wild	1	—	1	—	100.00	—
Total	743	278	70	11		

generation (see 'Agouti strain', combined  $F_1$  and  $F_2$ ). In another cross Lilacs were mated to Castorrex; these were white fatted but carried the factor for yellow fat, which appeared in the first cross and in the second generation (viz.  $F_2$  agouti). We shall revert to these later. (The carcass records are not, however, inclusive of complete generations.) Apart from these groups it will be seen from Table 1 that no rabbits with coloured fur contained more than 5% of yellow fat if the sexes were combined. The only other coloured rabbits with any yellow fat were a few Dutch, Havana Rex, Steel (so pale as to be a doubtful yellow) and Flemish. The remainder of these coloured rabbits had white fat.

Among *albino* rabbits, however, there is seen to be a much higher proportion of yellow-fatted animals, ranging from 10 to 40 % in the various sex groups, or even higher in the small number of White Beverens. The sequence in which these varieties are tabulated follows the same order as the slaughter weights. If, however, they are regrouped as coloured and true albino rabbits the proportion of yellow-fatted carcasses is much lower in coloured rabbits than in the true albino. Furthermore, although there is no sex difference in this respect in the coloured rabbits (2.4 % for males and 2.7 % for females) the albino males have a higher proportion of yellow-fatted carcasses (31.1 %) than the albino females (12.1 %), and albino females have a higher proportion than coloured females.

Table 2. *Distribution of yellow fat in coloured versus albino animals*

Group	White fat		Yellow fat		% yellow fat	
	Males	Females	Males	Females	Males	Females
Coloured and Himalayans	621	249	15	7	2.36	2.73
True Albino	122	29	55	4	31.07	12.12
Total	743	278	70	11	8.61	3.81
	1021		81		7.35	

It will be noted that although there is such a high percentage of yellow fats in albinos—and these were from several different sources, but were found in each strain—there were none in Himalayans of either the Rex, Normal or Angora coated stocks although the Himalayan is an allelomorph to true albino.

Other allelomorphs in the albinistic series include Sable and Chinchilla, all of which were white fatted, as were twenty-five  $F_2$  of this colour from Chinchilla  $\times$  Castorrex, although twenty-eight Agouti  $F_2$  from the same series included nine yellow fats. A white-fatted Chinchilla  $\times$  Albino gave nineteen white-fatted carcasses. If Chocolate is linked to albinism it should be included; very few indeed (less than 1 %) of this colour (Havana, Rex and Chocolate) had other than white fat. Dilute Chocolate, viz. Lilac groups, were all white fatted but some carried the yellow recessive, as shown by the cross to Castorrex.

Table 3. *Distribution of yellow fats in albinistic and in full-coloured rabbits*

Variety	White fat		Yellow fat		% yellow fat	
	Males	Females	Males	Females	Males	Females
True Albino	122	29	55	4	31.07	12.12
Himalayan	24	1	0	0	0.0	0.0
Sable	3	1	0	0	0.0	0.0
Chinchilla	46	28	0	0	0.0	0.0
Chocolate	139	67	2	0	1.42	0.0
Lilac	76	33	0	0	0.0	0.0
Full colour	328	119	13	7	3.81	5.56
Total	743	278	70	11	8.61	3.81

Whilst the occurrence of yellow fat in albinos is not incompatible with the genetic theory once the 'cross-over' has occurred, it is rather surprising to find such a high proportion of yellow fats in this group, but the almost complete absence of yellow in the remainder of the albinistic series is what might be expected on such a hypothesis.

Animals which were grazed tended to have deeper-coloured fat than the indoor stock, although Angoras which had been clipped several times, and so called upon to utilize adipose deposits, were often of a noticeably deeper colour. Grazed animals rarely had

such large deposits of fat as the comparable stock reared indoors. The deeply pigmented fat is detrimental to satisfactory marketing of rabbit meat since the pre-war price declined as much as 20 %, or occasionally more, compared with similar carcasses containing white fat.

Additional data on fat colour are provided by the records of a further batch of 1034 rabbits which are grouped in Table 4. The number of true Albinos is unfortunately small

Table 4. *Additional data on rabbit fat colour*

Variety	White fat		Yellow fat		% yellow fat	
	Males	Females	Males	Females	Males	Females
True Albino	8	4	1	1	11.11	20.00
Himalayan	1	0	0	0	0.00	0.00
Sable	8	5	0	0	0.00	0.00
Chinchilla	17	14	0	0	0.00	0.00
Chocolate self	129	101	4	5	3.01	4.72
Lilac	12	7	1	0	7.69	0.00
Full colour	404	310	1	1	0.25	0.32
Total	579	441	7	7	1.19	1.56

and the records for this class do not contribute much further information than that already provided in Table 3. Himalayan, Sable and Chinchilla again show no yellow fat but Chocolate have about 4 %. In the full colour class there is a negligible proportion of yellow fat, due to culling, which contrasts strongly with the data in Table 3.

The combined data are given in Table 5.

Table 5. *Fat colour in 2136 rabbit carcasses*

Variety	White fat		Yellow fat		% yellow fat	
	Males	Females	Males	Females	Males	Females
True Albino	130	33	56	5	30.11	13.16
Himalayan, Sable and Chinchilla	104	49	0	0	Nil	Nil
Chocolate	268	168	6	5	2.19	2.89
Lilac	88	40	1	0	1.12	Nil
Full colour	732	420	14	8	1.88	1.83
Total	1322	719	77	18	5.50	2.44

## SUMMARY

1. A large sample of many varieties of rabbit, fed on diets containing colouring matter, showed a very much higher proportion of yellow fat in true albino (27.2 %) than in other (1.9 %) rabbits.

2. Yellow fat occurred more frequently in albino males (30.1 %) than in albino females (13.2 %), but in coloured rabbits yellow fat occurred in about the same proportion for males (1.9 %) and females (1.8 %).

3. Indoor feeding resulted in greater fat deposition than outdoor grazing but the fat of grazed animals tended to be more deeply pigmented.

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