Potential usefulness of the *Na* (*Naked Neck*) gene in poultry production

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Introduction

The *Naked Neck* type has long been known in the domestic fowl. Its description has been reviewed by Hutt (1949). Davenport (1914) and Warren (1933) demonstrated that this trait is caused by a dominant gene, called *Na* by Hertwig (1933). Greenwood (1927) described in detail the peculiarities of the plumage of *Naked Neck* birds. They differ from other birds in that the zones separating the pterylae, or apteria, are entirely devoid of feathers or down and, in addition, certain pterylae are substantially reduced, not only in the neck area but also on the breast, thighs and other parts.

The *Na* gene was reported to be linked with *P* (pea comb) and *O* (blue egg): see Somes (1984). These loci are located on chromosome 1 (Zartman, 1973; Bitgood *et al.*, 1980). However the reported linkage of *Na* with these genes was loose, and its reality has been questioned (Bitgood *et al.*, 1980).

The *Na* allele is incompletely dominant. The homozygous (*Na Na*) birds can be distinguished by sight from the heterozygotes according to Crawford (1976) and Scott and Crawford (1977). The latter genotype shows a tuft of several dozen feathers on the front of the neck which is absent or reduced to a few units in the homozygote. According to our observations (unpublished), the larger extension of apteria on the ventral face of the thighs and on the breast for *Na Na* birds is an additional criterion of discrimination (Bordas *et al.*, 1978).

Geographical distribution

The *Na* gene is widespread in local populations in various countries and is a characteristic feature of a few breeds. Table 1 summarizes the data on its world distribution.

Among breeds reputedly fixed for the *Na* gene, *Transylvanian Naked Necks*, already mentioned by Hutt (1949), were widespread in the past century in this area of Central Europe (Horn, personal communication). In France, the “*Cou nu du Forez*”, at present a fancy breed, stems from a small region (Forez) of Central Southern France. In the area of “Landes” in the Southwest, the *Na* gene has been fixed from local populations for the production of broilers with a “label of quality” (Perrault, personal communication). However, the majority of apparently unselected local populations containing an appreciable proportion of *Naked Neck* birds appears to be located in subtropical, tropical or equatorial zones, especially those with hot and humid climates.

TABLE 1: Data on the geographical distribution of the *NAKED NECK* gene

Country	Breed (B) or Local population (LP)	Reference (*)
<i>America</i>		
* West Indies	LP	HUTT (1949)
* West Indies (Trinidad, Tobago, Puerto Rico, Virgin Islands, Jamaica)	LP	P.C. to R.D. CRAWFORD
* Mexico	LP	P.C. to author
* Brazil	LP	P.C. to R. D. CRAWFORD P.C. to author
<i>Africa</i>		
* Egypt, Burkina Faso, Togo, Ivory Coast, Madagascar	LP	P.C. to author
* Ghana, Somalia	LP	P.C. to R. D. CRAWFORD
* Zaïre	B (<i>Shingangadi</i>)	MICHELS & BODDEZ (1970)
<i>Asia</i>		
* India (Bombay area)	B	BHAT (1980)
* Malaysia	LP	P.C. to R. D. CRAWFORD; P.C. to author
* Malaysia	B (<i>Malay game</i>)	BHAT (1980)
<i>Europe</i>		
* Central Europe (Hungary, Romania)	B (<i>Transylvanian Naked Neck</i>)	HORN, P.C. to author
* France, South Central area	B (<i>Cou Nu du Forez</i>)	P.C. to author
* France, South Eastern Area	B (fixed from LP)	PERRAULT, P.C. to author

(*) P.C. = Personal communication

Associated effects on growth rate and body composition of broilers

Growth rate and feed efficiency

Table 2 groups the available comparisons between genotypes at the *Na* locus for body weight and feed efficiency from 1 day to 8 or 10 weeks of age. The data of Simon (1972) and Touchburn (1980) (limited to a short period and mainly aimed at evaluating the effect of the *Na* gene on lipogenesis and lipolysis) were not included neither were the results of Fraga (1982), mentioning the lack of significant effect on growth rate to 6 and 8 weeks of age associated with the *Naked Neck* gene.

Most results are a comparison between genotypes in a single environment (temperature after 4 weeks of age), but in two experiments the same genotypes were distributed in two environments allowing a test of the genotype temperature interaction. The results are detailed by sex, and indicate the type of strain used (arbitrarily defined as “heavy” if average 8-week weight, sexes being pooled, is more than 1.5 kg, and “light” if less than 1 kg), the husbandry system (floor vs. cages) and protein level of the rations.

At 20°C and below, the differences between genotypes are small in most cases, although in two instances (Merat, 1979 for males; Monnet *et al.*, 1979 for females at the lower temperature) a slight handicap is suggested for the *Naked Neck* birds.

Reference	Sex	Type: Heavy (H) or Light (L) (see text)	Floor (F) cages (C)	% protein in feed	Ambient temperature after 24 weeks (°C)	Age (wks)	Comparison within environment only (I) or genotypes in two environments (II)	Deviation of Na Na ⁺ and Na Na ⁺ from Na ⁺ Na ⁺ and significance of F test	F test	Na Na ⁺	Na Na ⁺	Feed efficiency (g feed/g weight gain)	F test
MERAT 1979	♂	L	F	18 ⁽¹⁾	15 to 20 ⁽³⁾	8	I	-	1.8	-	-	-	
	♂	L	F	18	15 to 20 ⁽³⁾	8	I	+ 11.5	- 1.5	-	-	-	
BORDAS et al. 1978	♂	L	F	18	31 ⁽³⁾	10	I	- 5.1	+ 11.3	-	- 5.4	+ 0.4	NS
	♂	L	F	18	15 to 20 ⁽³⁾	10	I	+ 11.4	- 4.1	-	- 5.4	- 1.7	NS
MONNET et al. 1979	♂	L	F	18	31 ⁽³⁾	10	I	+ 1.4	+ 9.6	-	0	+ 9.6	NS
	♂	L	F	18	15 to 20 ⁽³⁾	10	II	+ 12.5	- 3.3	-	+ 8.5	- 1.1	(5)
	♂	L	F	18	31 ⁽³⁾	10	II	+ 15.8	+ 9.2	-	+ 11.2	+ 3.7	(5)
HANZL & SOMES 1983	♂	H	C (groups)	28	21 ⁽²⁾	8	II	-	0.0	-	-	-	
	♂	H	C (groups)	(2)	21 ⁽²⁾	8	II	+ 13.6	- 7.3	-	-	-	
	♂	H	C (groups)	(2)	38 ⁽⁴⁾	8	II	+ 18.6	- 6.7	-	-	-	
	♂	H	C (groups)	(2)	38 ⁽⁴⁾	8	II	-	-	-	-	-	
ZEIN-EL-DEIN et al. 1984 a	♂	L	F	16	29 ⁽³⁾	10	I	-	+ 4.4	-	-	-	NS
	♂	L	F	16	24 ⁽³⁾	10	I	-	+ 3.1	-	-	-	(5)
	♂	L	C	20	29 ⁽⁴⁾	10	I	-	-	-	-	-	NS
	♂	L	C	20	24 ⁽³⁾	10	I	-	+ 1.3	-	-	-	(5)
	♂	L	F	22 then 20	20 ⁽³⁾	8	I	-	- 4.6	-	-	-	(5)
EL-ATTAR & MERAT 1985	♀	H	F	20	20 ⁽³⁾	8	I	-	+ 3.0	-	-	-	NS
	♀	H	F	22 then 20	20 ⁽³⁾	8	I	-	- 1.9	-	-	-	NS
	♀	H	F	18	25 ⁽⁴⁾	8	I	-	- 0.8	-	-	-	(5)
MERAT (unpublished)	♂	H	F	18	25 ⁽⁴⁾	8	I	-	- 0.3	-	-	-	(5)
HAMMADE et al. (to be published)	♂	L	C	20	18	8	II	- 1.8	- 0.9	-	-	-	(7)
	♂	L	C	20	30	8	II	+ 1.4	+ 3.2	-	-	-	(7)
	♂	L	C	20	18	13	II	- 5.2	- 4.4	-	-	-	(7)
	♂	L	C	20	30	13	II	+ 4.3	+ 5.7	-	-	-	(7)

(1) from day-old to slaughter age; (2) Not given. "Starter" ration to 4 wks, then "finishing"; (3) with fluctuations; (4) constant ($\pm 1^\circ\text{C}$); (5) no statistical test (measurement as a group for each genotype); (6) not tested within environment, but G $\times$ E interaction significant for body wt (***) and feed efficiency (***) (7) not tested within environment; G $\times$ E interaction significant for 13 wk body wt.

Only the data of Hanzl and Somes (1983) showed a marked inferiority of *Naked Neck* homozygous and heterozygous females and of heterozygous males as compared to the $na^+ na^+$ genotype. Conversely, in the two cases where it was measured at moderate temperature, the feed efficiency of *Naked Neck* chickens deteriorated in comparison with normally-feathered chicks, as might be expected from the larger extension of unfeathered areas, increasing the heat loss of the former.

At 24°C (Zein-el-Dein *et al.*, 1984) or at 25°C $\pm$ 1°C (Merat, unpublished) differences in growth rate were small and insignificant, and the disadvantage shown for *Naked Neck* bird feed efficiency at lower temperatures did not appear.

Finally, when approaching or exceeding 30°C, the performances of *Naked Neck* homozygous or heterozygous chickens are consistently superior to those of $na^+ na^+$ birds of the same origin. At 29°C (Zein-el-Dein *et al.*, 1984a) this advantage was limited and non-significant for body weight; feed efficiency seemed slightly better although not significantly, for the *Naked Neck* genotypes; in addition, the data suggested that the advantage is more marked when a ration with a lower protein level is given. At 31°C, the superiority for growth rate to 10 weeks of age, observed by Bordas *et al.* (1978) on males and by Monnet *et al.* (1979) in both sexes for both *Na Na* and *Na na^+* genotypes, was significant and attained more than 10 per cent. In the experiment of Hanzl and Somes (1983) at 38°C, *Naked Neck* homozygotes showed a marked advantage for body weight which was less for heterozygotes. Feed efficiency was slightly, but not significantly, better for *Naked Neck* chicks at 31°C and 38°C, respectively, (Bordas *et al.*, 1978; Monnet *et al.*, 1979; Hanzl and Somes, 1983).

Body composition, slaughter yield and meat yield

Table 3 summarizes published data on body composition and yield of *Naked Neck* chickens compared with chicks with normal plumage. The table includes the three criteria showing the most conspicuous differences between the genotypes: feathers as per cent of body weight, eviscerated carcass as per cent of live weight and meat yield as per cent of eviscerated carcass weight. As in Table 2 the deviations of the *Na Na* and *Na na^+* genotypes from the mean value of the $na^+ na^+$ genotype are given, but here this deviation represents a difference on a variable already expressed in percent.

For these traits the difference between genotypes do not seem to depend on environment conditions such as temperature. Except in one case, the proportion of feathers of *Na na^+*, and even more of *Na Na*, birds was consistently and highly significantly lower than that of $na^+ na^+$ chickens. The reduction of the plumage in proportion to live weight was of the order 1.5 to 2% and 2.5 to 3% for the *Na na^+* and *Na Na* genotypes respectively. This may explain entirely the improvement of slaughter yield associated with these genotypes, which is regularly found although it is not always significant.

Another consistent highly significant difference in the data of Zein-el-Dein *et al.* (1984b), concerns meat yield (percentage of muscles) of the eviscerated carcass which is superior for the *Na na^+* genotype compared with $na^+ na^+$ (*Na Na* was not included in this experiment). El-Attar and Merat (1985) indicated that this difference is located in the trunk and probably is due to breast muscles. The advantage of the *Na na^+* chicken for meat yield is variable. The results from Table 3 suggest that it may be relatively higher in medium or light-weight populations, and possibly also in those given a low protein diet (Zein-el-Dein *et al.*, 1984b). This table does not include traits associated with fatness. For abdominal fat as defined according to

Type:	%	Ambient	Slaughter	Mean deviation of Na Na and Na na ⁺ genotypes from na ⁺ na ⁺ %
1	100	100	100	0
2	100	100	100	0
3	100	100	100	0
4	100	100	100	0
5	100	100	100	0
6	100	100	100	0
7	100	100	100	0
8	100	100	100	0
9	100	100	100	0
10	100	100	100	0
11	100	100	100	0
12	100	100	100	0
13	100	100	100	0
14	100	100	100	0
15	100	100	100	0
16	100	100	100	0
17	100	100	100	0
18	100	100	100	0
19	100	100	100	0
20	100	100	100	0
21	100	100	100	0
22	100	100	100	0
23	100	100	100	0
24	100	100	100	0
25	100	100	100	0
26	100	100	100	0
27	100	100	100	0
28	100	100	100	0
29	100	100	100	0
30	100	100	100	0
31	100	100	100	0
32	100	100	100	0
33	100	100	100	0
34	100	100	100	0
35	100	100	100	0
36	100	100	100	0
37	100	100	100	0
38	100	100	100	0
39	100	100	100	0
40	100	100	100	0
41	100	100	100	0
42	100	100	100	0
43	100	100	100	0
44	100	100	100	0
45	100	100	100	0
46	100	100	100	0
47	100	100	100	0
48	100	100	100	0
49	100	100	100	0
50	100	100	100	0
51	100	100	100	0
52	100	100	100	0
53	100	100	100	0
54	100	100	100	0
55	100	100	100	0
56	100	100	100	0
57	100	100	100	0
58	100	100	100	0
59	100	100	100	0
60	100	100	100	0
61	100	100	100	0
62	100	100	100	0
63	100	100	100	0
64	100	100	100	0
65	100	100	100	0
66	100	100	100	0
67	100	100	100	0
68	100	100	100	0
69	100	100	100	0
70	100	100	100	0
71	100	100	100	0
72	100	100	100	0
73	100	100	100	0
74	100	100	100	0
75	100	100	100	0
76	100	100	100	0
77	100	100	100	0
78	100	100	100	0
79	100	100	100	0
80	100	100	100	0
81	100	100	100	0
82	100	100	100	0

Reference	Sex	Heavy (H) or Light (L) (see text)	protein in ration	temperature after 4 wks (°C)	age (d)	Feathers % of live wt				Eviscerated carcass %				Meat yield % of eviscerated carcass	
						Na	Na	Na	Na	Na	Na	Na	Na	Na	S of F-test
						Significance S of F-test				Significance S of F-test				Significance S of F-test	
BORDAS et al. 1978	♂	L	18	31 ⁽¹⁾	70	-2.4	-1.8								
	♂	L	18	15 to 20 ⁽¹⁾	70	-3.1	-2.0								
	♂	L	18	31 ⁽¹⁾	70	-3.0	-1.4								
	♂	L	18	15 to 20 ⁽¹⁾	70	-2.9	-1.8								
ZEIN-EL-DEIN et al. 1981	♂	L ⁽¹⁾	not given	not given	56	-	-1.9								
	♂	H	(2)	38 ⁽⁴⁾	56										
	♂	H	(2)	38 ⁽⁴⁾	56										
	♂	H	(2)	38 ⁽⁴⁾	56										
HAINZL & SOMES 1983	♂	H	not given	not given	56										
	♂	H	(2)	38 ⁽⁴⁾	56										
	♂	H	(2)	38 ⁽⁴⁾	56										
	♂	H	(2)	38 ⁽⁴⁾	56										
ZEIN-EL-DEIN et al. 1984b	♂	L	16	20 ⁽⁴⁾	75		-1.7 ⁽⁷⁾								
	♂	L	20	20 ⁽⁴⁾	75		-1.9								
	♂	L	16	24 ⁽³⁾	82		-1.7 ⁽⁷⁾								
	♂	L	20	24 ⁽³⁾	82		-2.0								
EL-ATTAR & MERAT 1985	♂	H	22 then 20 ⁽⁸⁾	average 20 ⁽⁸⁾	60		-1.2 ⁽⁷⁾								
	♂	H	22 then 20 ⁽⁸⁾	average 20 ⁽⁸⁾	60		-1.7								
	♂	H	22 then 20 ⁽⁸⁾	average 20 ⁽⁸⁾	60		-1.7								
	♂	H	22 then 20 ⁽⁸⁾	average 20 ⁽⁸⁾	60		-1.7								

(1) Favourable cross (about 750 g, sexes pooled); (2) Not given; "starter" ration to 4 wks, then "finishing"; (3) with fluctuations; (4) constant ($\pm 1^\circ\text{C}$); (5) "starter" ration, then "finishing"; (6) variance between genotypes tested on whole data; (7) variance between genotypes tested within each sex.

Ricard and Rouvier (1967) and Bordas *et al.* (1978), on male chickens raised at 31°C, did not find significant differences associated with genotypes at the *Na* locus; a tendency to a slightly higher value for *Naked Neck* birds might reflect their higher growth rate at this temperature. On the other hand, Zein-el-Dein *et al.* (1984 b) and El-Attar and Merat (1985) measured abdominal fat and subcutaneous and intermuscular fat in the eviscerated carcass. Table 4 shows their results in a comparison of *Na na*⁺ and *na*⁺ *na*⁺ birds for these criteria.

TABLE 4: Comparison between genotypes at the *Na* locus for criteria of fatness

Reference, sex and experimental group	Abdominal fat % of live wt		Intermuscular and subcutaneous fat % of eviscerated carcass	
	<i>Na na</i> ⁺ (deviation from <i>na</i> ⁺ <i>na</i> ⁺ %)	Significance	<i>Na na</i> ⁺ (deviation from <i>na</i> ⁺ <i>na</i> ⁺ %)	Significance of the "genotype" effect
ZEIN-EL-DEIN <i>et al.</i> 1984b				
♂, 16% protein in feed	– 0.1	N.S.	– 2.0	***
♂, 20% protein in feed	– 0.1	N.S.	– 0.9	
♀, 16% protein in feed	– 0.4	N.S.	– 1.9	**
♀, 20% protein in feed	– 0.1	N.S.	– 0.7	
EL-ATTAR & MERAT 1985				
♂	+ 0.3	N.S.	– 0.7	N.S.
♀	+ 0.7	N.S.	– 0.4	N.S.

While abdominal fat does not differ according to genotype, the total of the percentage of subcutaneous and intermuscular fat is significantly lower in *Naked Neck* heterozygotes in the data of Zein-el-Dein *et al.* (1984 b), and the trend is the same, although not significant, in results for El-Attar and Merat (1985). This may be related to the analysis of total lipids in the carcass made by Hanzl and Somes (1983) who showed a significantly lower value for the *Naked Neck* genotypes than for wholly-feathered birds.

Finally, Zein-el-Dein *et al.* (1981) and Zein-el-Dein *et al.* (1984b) found that the head as a percent of live weight was significantly reduced by the *Na* gene; Zein-el-Dein *et al.* (1984b) in females and El-Attar and Merat (1985) in both sexes found a reduction for the neck in proportion to live weight and Zein-el-Dein *et al.* (1981) drew a similar conclusion for shanks in females. These parts contain a high proportion of bone and may be compared to the higher proportion of muscles and lower proportion of skeleton found consistently in the eviscerated carcass of *Naked Neck* birds (Table 3).

Effects on egg production traits

The only available data on the effects associated with the *Na* gene on egg production traits are those obtained by Bordas *et al.* (1980) and Monnet *et al.* (1980) in a normal sized (*Dw*) population, and those presented by Merat and Bordas (1974) and Bordas and Merat (1984) evaluating the combined effects of genotypes at the *Na* and *Dw* (sex-linked dwarfism) loci. The recent unpublished data of the latter authors are included. Horst (1980) also reported briefly that at high ambient temperature the *Naked Neck* gene is associated with a 7.4% gain in total egg mass during the first 3 months of production, while Smith and Lee (1977)

mention the lack of significant differences for egg laying and mean egg weight between *Na na*⁺ and *na*⁺ *na*⁺ genotypes at moderate temperature.

Table 5 condenses the published data comparing the 3 genotypes at the *Na* locus for parameters related to egg production and feed efficiency. Both cited works include a “control” and a “heated” group.

TABLE 5. Comparison between genotypes at the *Na* locus for egg production and feed efficiency of normal-sized (*Dw*) or Dwarf (*dw*) females at two temperatures

	Comparison in a normal-sized (Dw) strain (Bordas et al., 1980)			Comparison in a dwarf (dw) strain (Bordas & Merat, 1984)		
	Mean value as % of na ⁺ na ⁺		Significance of the “genotype” effect	Mean value as % of na ⁺ na ⁺		Significance of the “genotype” effect
	Na Na	Na na ⁺		Na Na	Na na ⁺	
	CONTROL (15 to 20°C)			CONTROL (15 to 20°C)		
Body wt (39 wks)	89.5	93.9	***	86.1	94.1	**
Egg number to 39 wks	96.2	98.9		96.7	102.0	
Mean egg wt (37 to 39 wks)	104.4	100.4	**	101.4	102.3	
Egg mass/28 d. (27 to 39 wks)	101.7	104.2		101.0	106.5	
Feed efficiency: g feed/g eggs (27 to 39 wks)	109.1	92.2		93.6	90.7	
% cracked eggs (27 to 39 wks)	161.4	80.7		143.9	114.6	
	HEATED Group (31°C)			HEATED Group (31°C)		
Body wt (39 wks)	105.5	103.4		100.3	100.3	
Egg number (to 39 wks)	104.7	102.2		102.4	99.4	
Mean egg wt (37 to 39 wks)	109.2	106.2	***	107.1	102.3	***
Egg mass/28 d. (27 to 39 wks)	110.5	104.9		122.9	111.6	***
Feed efficiency (27 to 39 wks)	99.7	100.8		88.2	93.1	*
% cracked eggs (27 to 39 wks)	83.8	94.8		86.3	138.9	

The results of both experiments are similar for most criteria. In the control group, an appreciable depression of adult body weight is associated with the *Na Na* genotype in both normal-sized (*Dw*) and sex-linked dwarf (*dw*) hens (around 15%) and to a much lesser extent with the *Na na*⁺ genotype¹. In spite of this, average egg weight is slightly increased for *Naked Neck* hens (significantly in the first experiment on a *Dw* strain). The same appears for total egg mass produced per 28 days. In contrast, egg number and percent of cracked eggs do not differ significantly according to genotype at the *Na* locus, although according to other unpublished data the *Na Na* hens might produce slightly more shellless eggs. In the group at higher temperature, there were no differences between genotypes for body weight. Conversely, the superiority of the *Na na*⁺ and to a larger extent of the *Na Na* genotype for mean egg weight and egg mass is more marked than in the control and is always highly significant for egg weight which was higher by more than 3 grams in *Na Na* hens

¹ This tendency is found also for the adult body weight of males, but to a less extent with a 4% difference between the homozygous genotypes (unpublished data).

than in the $na^+ na^+$ genotype. As in the control group, egg number and the percent of cracked eggs did not show any appreciable difference between genotypes, although for this last trait an advantage of $Na Na$ layers at high temperature is suggested.

Feed efficiency is the only criterion for which the genotypes at the Na locus do not differ in the same way in a normal-sized (Dw) strain (experiment 1) and a dwarf (dw) strain (experiment 2). In the first case, although the differences in feed efficiency are not significant, the $Na Na$ hens were the least efficient in the control environment, easily explained by their excessive heat dissipation. This handicap is not found in the high-temperature group. Among dwarf hens the feed efficiency was always better (or at least equal) for the *Naked Neck* genotypes compared to the $na^+ na^+$ genotype, whatever the environmental temperature. Bordas and Merat, (1984) suggested that the reason for this is different depending on the ambient temperature. In the "control" at moderate temperature, it was due to the reduction of $Na Na$ and $Na na^+$ body weight without any depression in egg weight, but at a higher temperature it was due to the larger increase in mean egg weight and the egg mass for these genotypes without a proportional increase in feed intake. On the other hand, the deviation from a multiple regression equation, called "residual" food consumption at fixed body weight and egg production (Bordas and Merat, 1984), did not differ at high temperature. On the contrary, the differences between the genotypes $Na Na$, $Na na^+$ and $na^+ na^+$ in the control environment were much larger in the experiments with Dw females than with dwarf hens (Bordas and Merat, 1980, 1984).

In order to evaluate the effects associated with the $Na Na$ and $Na na^+$ genotypes at a temperature intermediate between those realized in the previous experiments, a new comparison was undertaken at a constant temperature of 25°C from the age of 18 weeks, the mean daily temperature between 4 and 18 weeks varying approximately between 15 and 20°C. A dwarf (dw) strain segregating for the Na gene was used. Table 6 shows the main results (unpublished).

TABLE 6: Comparison between genotypes at the Na locus for egg production and feed efficiency: Dwarf females at 25°C. (unpublished data)

Trait	Mean values		
	$Na Na$	$Na na^+$	$na^+ na^+$
Body wt at 39 wks (g)	1608	1683	1663
Egg number (to 39 wks)	106.5	111.9	109.1
Mean egg wt from 37 to 39 wks (g)	51.9	52.4	51.0
Egg mass/28 d. from 27 to 39 wks (g)	929	990	926
Feed efficiency (g. feed/g eggs) from 27 to 39 wks	2.98	2.89	2.93
% broken eggs (27 to 39 wks)	0.8	0.7	0.7

— N = 64 per genotype

— No trait shows any significant difference between genotypes

In this environment, the effect of the Na gene on adult body weight was less than at lower temperatures, the differences between $Na Na$ and $na^+ na^+$ females decreasing between 18 and 39 weeks of age. The difference in mean egg weight showed the same trend but less than at 30°C. There were no appreciable differences

between genotypes for feed efficiency so that at 25°C the *Na Na* and *Na na*⁺ genotypes as compared with *na*⁺ *na*⁺ had only a 1 g advantage in mean egg weight.

Finally, the possibility that the increased feed consumption associated with the *Na* gene might have a beneficial effect in the presence of a ration with a suboptimal total protein level was investigated. This unpublished trial used a dwarf population with the *Na* allele segregating and with 12% total protein in the feed from the age of 18 weeks. The ambient temperature was 25°C from the same age. The results are shown in Table 7. No differences between genotypes at the *Na* locus appeared for body weight at 39 weeks and the differences in average egg weight were insignificant, but the trend was of the same order as in the previous experiment (Table 6). Laying rate and feed efficiency for egg production did not differ significantly according to genotype, but the egg mass produced in 28 days showed an advantage for *Naked Neck* layers, significant at the 5% level. This effect and the effect on mean egg weight however was not higher than with the higher protein level given in the experiment corresponding to Table 6.

TABLE 7: Comparison between genotypes at the *Na* locus for egg production and feed efficiency: Dwarf hens at 25°C, feed with 12% total protein

Trait	Mean value			Significance of the genotype effect
	<i>Na Na</i>	<i>Na na</i> ⁺	<i>na</i> ⁺ <i>na</i> ⁺	
Body wt at 39 wks (g)	1635	1642	1632	
Egg number to 39 wks of age	115.2	117.9	112.0	
Mean egg wt at 40 wks (g)	52.6	52.0	51.3	
Egg mass/28 d. from 27 to 39 wks (g)	899	885	828	*
Feed efficiency (g feed / g eggs) from 27 to 39 wks	3.23	3.24	3.19	
% cracked eggs from 27 to 39 wks	5.0	6.1	4.5	

N = 40 per genotype

Effects on reproduction and viability

Fertility

At moderate temperatures, Smith and Lee (1977) mentioned briefly that they observed no differences between *Na na*⁺ and *na*⁺ *na*⁺ cocks for fertility, sperm concentration or number of matings. There are no other published results on fertility in relation to the *Naked Neck* gene. Table 8 condenses data from Hammade *et al.* (1986a, b) on semen traits and a fertility test on cocks of the genotypes *Na Na*, *Na na*⁺ and *na*⁺ *na*⁺ in individual cages distributed into two groups, one maintained at 18 ± 1°C from the age of 4 weeks and the other at 30 ± 1°C, with 40 individuals per subgroup.

On the whole, a significantly higher value of the *Na Na* genotype over the normal homozygote for semen volume and number of spermatozoa at various ages appears, the *Na na*⁺ genotype being intermediate. There is no significant interaction between genotype and temperature. On the other hand, the differences at the level

TABLE 8: Comparison between genotypes at the Na locus for semen traits and male fertility at two temperatures. (from Hammade et al, 1986b)

Trait	Mean values				Significance				
	Na Na	at 18°C Na na ⁺	na ⁺ na ⁺	Na Na	at 30°C Na na ⁺	na ⁺ na ⁺	Genotype	temperature	interaction
Semen volume (ml):	1.58	1.35	1.03	1.27	1.15	0.87	**	**	
	1.39	1.27	1.00	1.09	1.11	0.88	**	*	
	1.37	1.12	0.93	0.90	0.90	0.66	**	**	
Sperm concentration (10 ⁹ /ml):	5.23	5.10	4.80	5.11	4.99	4.44		**	
	4.29	4.62	4.43	4.68	5.24	5.16			
	3.85	4.28	3.98	4.04	4.19	4.18			
Number of spermatozoa (10 ⁹):	2.86	2.46	2.03	2.24	2.13	1.50	**	**	
	2.23	2.12	1.66	1.86	2.09	1.64	**		
	1.89	1.76	1.39	1.35	1.46	1.03	**	**	
Fertile eggs (%) ⁽¹⁾	88.7	91.3	91.4	91.8	92.5	93.2			

(1) Hens inseminated by mixed semen from 5 cocks per subgroup.

of semen concentration are not reflected in fertility. This trait, however, was estimated only from the pooled semen of 5 males per genotype and environment, and no statistical test was possible.

Embryonic mortality

Crawford (1977, 1978) published data on hatching percentage according to the genotype of the embryos at the *Na* locus. He concluded a slight disadvantage for the *Na Na* and to a lesser extent, the *Na na*⁺ embryos. Horst (1980) points to a 13% reduction of embryonic survival associated with the *Na* allele. Our results (unpublished) agree with this. On a series of hatches from heterozygous (*Na na*⁺) parents, the numbers of hatched chicks, sexes pooled for genotypes *Na Na*, *Na na*⁺ and *na*⁺ *na*⁺, were 765 (24.2% of the total), 1539 (48.7%) and 866 (27.1%) respectively. By comparison with the expected proportions testing the hypothesis of equal hatching rate for the three genotypes, these figures suggest that the survival of *Na na*⁺ embryos was only 90% and that of *Na Na* embryos 89.5% that of homozygous normally-feathered zygotes.

These postulated effects on hatching rate may not suffice to explain certain deviations to Mendelian proportions, previously observed and limited to one sex (Merat, 1970), for which a hypothesis of selective fertilization was suggested.

Post embryonic mortality

There are no published data on the mortality of *Naked Neck* compared to normally-feathered birds at different ages. Horst (1980) mentions (no figures given) that the *Naked Neck* gene seems to have a positive effect on chick viability at high ambient temperature. In the experimental conditions that achieved during the growth period (Bordas *et al.*, 1978; Monnet *et al.*, 1979) or at the laying stage (Bordas *et al.*, 1980; Monnet *et al.*, 1980), mortality was relatively low and did not differ according to the genotype at the *Na* locus.

Conversely, in the presence of a high sublethal temperature (heat stress), Smith and Lee (1977) observed a significantly higher survival rate for *Na na*⁺ chicks (51.4%) than for the “normal” *na*⁺ *na*⁺ genotype (38.8%). In an unpublished result a similar difference was obtained between male chicks of these two genotypes submitted to a temperature exceeding 40°C for several hours at the age of 2 days (heterozygous *Naked Neck*, 59.3% survivors among 108 hatched: normally-feathered chicks, 33.3% survivors among 105 hatched; $P < 0.001$).

Other effects

A consistent morphological effect noted in *Naked Neck* birds (Monnet *et al.*, 1979; Monnet *et al.*, 1980; Bordas *et al.*, 1984) is a significant 10 to 20 percent increase of wattle size in both sexes and at all ages. This effect is local, as comb size is not higher for *Naked Neck* cocks compared to their fully-feathered counterparts (Hammade *et al.* 1986a).

The cloacal temperature of *Naked Neck* birds is slightly inferior on average to that of *na*⁺ *na*⁺ adult males and females; irrespective of the ambient temperature, the difference is about 0.1 to 0.2°C (Monnet *et al.*, 1979; Monnet *et al.*, 1980; Bordas and Merat, 1984. Hammade *et al.* (1986a) make the same observation on cockerels or cocks at different ages. Monnet *et al.* (1980) find a difference of the same type for the surface temperature of the shank, this difference being higher at 30°C than around 20°C. Hammade *et al.* (1986a), notice a similar effect on skin temperature in males at two ambient temperatures, 18°C and 30°C.

According to Monnet *et al.* (1980) in laying hens and Hammad *et al.* (1986a) in males at several ages, the packed cell volume of *Na Na* and *Na na⁺* birds is higher than that of *na⁺ na⁺* individuals at 30°C, but not at 18°C.

Monnet *et al.* (1980) mention that the water intake of *Naked Neck* hens is lower than that of fully-feathered hens at a high temperature; this may be attributed to their ability to dissipate heat into the environment more rapidly.

Zein-el-Dein *et al.* (1984c) observed a difference in the behaviour in several respects between *Naked Neck* and normally-feathered chickens in individual cages between the ages 1 and 10 weeks. *Naked Neck* chickens spent the same time at the troughs as their fully-feathered sibs but they stood up more often. Conversely, in 2 day old chicks in the open field, the *Na Na* genotype had a longer latency time before the first move and moved less in a given time than the other genotypes.

In response to starvation for 48 hours at 8 or 9 weeks of age, the relative body weight loss of the *Naked Neck* birds was not significantly different although it was slightly lower than that of *na⁺ na⁺* birds, and the depression of body temperature and of plasma glucose did not differ from those of fully-feathered birds (Zein-el-Dein *et al.*, 1982).

Interpretation of effects associated with the NA gene

Effects on plumage and on energy balance and its consequences

The effect of the *Na* gene on plumage weight in proportion to live body weight in both the heterozygous and the homozygous states, causing an improvement of yield of the eviscerated carcass (Zein-el-Dein *et al.*, 1984b), is a direct consequence of the restriction by this gene of several pterygiae and of feathers or the down cover of apteria. The effect itself has not been interpreted but it shows some analogies with that of the scaleless gene described by Abbot (1958) and others.

The insulating power of the plumage being well known, another expected consequence is an appreciable increase of heat loss, particularly at low or moderate environmental temperatures. This increase explains the higher feed intake and the poorer feed efficiency of *Naked Neck* chicks and layers, especially the homozygotes, observed in experiments done at 15 to 20°C. The survival advantage of the same genotypes when submitted to a heat stress (Smith and Lee, 1977; Merat, unpublished) is likely to have the same origin. It is suggested (Monnet *et al.*, 1979) that the same cause may be responsible for the superior growth rate of *Naked Neck* (*Na Na* and *Na na⁺*) chickens around 30°C and above. The heat production following meals, dissipated at a faster rate, would force the birds to reduce their feed intake less, resulting in a faster growth rate and at least as good feed efficiency as for normally-feathered chicks.

Effect on egg weight

Bordas and Merat (1984) studying data obtained at two different temperatures in a dwarf (*dw*) flock as compared with a normal (*Dw*) flock, showed that the increase of the ratio of mean egg weight to body weight of the laying hen is a constant effect associated with the *Na* gene in the homozygous state. The heterozygous genotype has a lower effect in the same direction. The excess of feed consumption of *Na Na*, and to a lesser extent that of *Na na⁺* hens, in comparison with the *na⁺ na⁺* genotype, may contribute to this increase in egg weight by the supply of additional material, protein and so on, for egg formation. This hypothesis is not supported by

direct evidence and there is no close relationship between the increase in egg weight associated with the *Na* gene and the corresponding increase of feed intake, according to ambient temperature or the size of the layer (*Dw* or *dw*). However, the effect of protein level on mean egg weight is known, as well as the fact that the optimum protein level for egg weight is higher than that corresponding to maximum egg number (Calet, 1972).

On the other hand, data on average egg weight were published in the past for two other genes suppressing or reducing the extension of the plumage: *sc* (scaleless, autosomal recessive suppressing the plumage: Abbott, 1958; Abbott and Asmundson, 1962) and the *K*ⁿ allele at the sex linked K locus, which considerably delays feathering (Somes, 1975). In both cases, the mean egg weight was several grams higher in the presence of the mutant genotype without a parallel increase in body weight.

Depressing effect on body weight at low or moderate temperature

There is no satisfactory explanation for the substantial reduction in body weight of *Naked Neck* females (mainly homozygotes) at moderate temperatures (15 to 20°C) in the data presented by Monnet *et al.* (1980) and Bordas and Merat (1984). It is possible that the compensation for the energy requirement by additional feed intake associated with the *Na Na* genotype was not sufficient, as suggested from the slight depression of body temperature observed by Monnet *et al.* (1980), and that in the long run the consequences on weight gain are cumulative. The fact that only the late growth period is concerned might be in accordance with this hypothesis, along with the fact that from 7 weeks of age the blood concentration of thyroid hormone T3 decreases, which may be associated with a decreasing metabolic rate (Decuypere *et al.*, in press). On the other hand, the additional feed consumption associated with the *Naked Neck* type includes calcium. Can a difference in the consumption of this element have consequences on the rate of skeletal maturation? Ekerman *et al.* (1981) showed that lowering the ingested energy at 8 weeks of age increased the calcification of the tibia, but of course the situation is different from that associated with the *Na* vs. *na*⁺ gene.

Effects on meat yield and fattening

The interpretation of the relatively faster development of the muscular tissue associated with the *Na* gene independently of body weight (Zein-El-Dein *et al.*, 1984 b), especially in the thoracic region (El Attar and Merat, 1985), calls for further investigations. Results from Somes and Johnson (1980) pointing to a better breast conformation associated with the scaleless gene that causes a similar but more extreme reduction of the plumage than the *Na* gene, suggest that this may be a general effect associated with a reduction in the plumage. It has been indicated (Zein-El-Dein *et al.*, 1984 b) that during growth, the formation of a smaller amount of feathers leaves more protein material available for other tissues, if nitrogen retention is unchanged. On the other hand Goldspink (1977) indicated that the number of muscular fibres, which is one of the factors of further muscle growth, is determined during embryonic life. During this time, the distribution of an obviously limited total protein supply between down and muscles might be shifted in *Naked Neck* embryos to the advantage of muscular tissue.

Conversely, the slight reduction of the proportion of subcutaneous and intermuscular fat in *Naked Neck* birds (Zein-El-Dein *et al.*, 1984 b) may correspond to the utilization of a higher part of the ingested lipids for thermoregulation.

Effects on semen traits and other effects

Among the other effects associated with the *Naked Neck* phenotype, those concerning semen characters (Hammade et al., 1986 a & b), increase of volume and number of spermatozoa irrespective of the ambient temperature, are not explained at present, nor are the effects on behaviour traits noted by Zein-El-Dein *et al.* (1984 c). The greater wattle size of *Na Na* and *Na na*⁺ birds is a local phenomenon. The extension of plumage around the wattles is reduced by the *Na* gene, and this may be compared with the reduction of comb associated with crest (*Cr* gene), or with that of wattles in the presence of the *Mb* gene responsible for feather extension in this area (Hutt, 1949).

Potential value of the *Naked Neck* gene in poultry production

The most likely potential use of the *Naked Neck* gene is at high ambient temperatures, from 25°C and mainly around 30°C and above.

The advantage of *Naked Neck* broilers for growth (Table 2) is variable, increasing with temperature and possibly depending on other uncontrolled factors, but on the whole the use of the *Na* gene appears as beneficial above 25°C, even if only the heterozygous *Na na*⁺ genotype is considered, which is more likely to be obtained in a terminal cross. Even at 25°C data (see later) show that *Naked Neck* chickens are at no disadvantage. Further work however will be necessary to establish if the *Na Na* or *Na na*⁺ genotype has the same effect on body weight gains in a fluctuating temperature environment and to what extent it depends on relative humidity. On the other hand, the suggestion of Zein-El-Dein *et al.* (1984 a) that *Naked Neck* birds show a slightly stronger advantage in the presence of a ration with suboptimal protein level needs additional confirmation, possibly using a still lower protein ration than that used by these authors.

To this variable advantage for growth associated with the *Naked Neck* genotypes at constant high temperature is to be added a consistent gain (about 1.5 to 2% with the heterozygous genotype) for yield of eviscerated or dressed carcass owing to the reduction of plumage. In addition there is a more variable but always positive effect on meat yield from 1 to more than 5% (Table 3) that mainly concerns ready-to-cook chicken meat. The slightly lower percentage of subcutaneous and inter-muscular fat in *Naked Neck* chicks (Zein-El-Dein *et al.*, 1984 b; El Attar and Merat, 1985) is also favourable. The reduction of plerylae, and of the down between them, would probably result in faster plucking leaving fewer pinfeathers. This seems to correspond to the general opinion of producers, who do not claim any harmful effect on the frequency of breast blisters and carcass condition (Perrault, personal communication).

Finally, a higher mean egg weight associated with *Na*, if this allele is incorporated into a dam line, might have a slightly favourable effect on chick weight to 7–8 weeks of age, due to the influence generally found to be associated with this egg weight (e.g. Bray and Iton, 1962; Merritt and Gowe, 1964; Morris *et al.*, 1968).

The depression of hatching rate suggested by Crawford (1977, 1978), Horst (1980) and our data (about 10% in relative terms) might be independent of climatic conditions. If so, it would be the only unfavourable effect associated with the *Naked Neck* character in a hot environment. It affects the cost of the day-old chicks. Taking this cost as 14 to 16% of the total cost of the broiler (North, 1984), this effect would represent not more than 1.5% of the total cost, which is less than the amount of gains on body weight and yield.

In total, the gain on body weight alone expected from the incorporation of the

Na allele in a parental line would be equivalent to few generations of selection, possibly not more than 1 or 2, but this number would be distinctly higher taking into account the effects on yield.

For egg production at high temperature, the most constant advantage associated with the *Naked Neck* genotypes is the increase of mean egg weight (Table 5). For the *Na Na* genotype at 30°C the corresponding gain in a normal-sized (*Dw*) strain or in a strain fixed for the sex-linked dwarf gene (*dw*) amounts to 4.5 and 3.7 g respectively. For the heterozygous genotype in the same conditions, the gain is about halved, which is still appreciable. Additional results are needed to confirm the suggestion (Monnet *et al.*, 1979; Bordas and Merat, 1984) of a better shell strength and a higher laying rate after the first 5 months of laying for the *Naked Neck* hens at 30°C.

The conclusions drawn for egg production are also likely to apply to female breeders in broiler production.

At moderate temperature, the use of the *Naked Neck* gene is obviously counterindicated for it appreciably reduces feed efficiency for both growth rate and egg production. Nevertheless, some results suggest that this defect may be corrected by a more precise control of the environment.

While at 15 to 20°C after the age of 4 weeks, *Naked Neck* chickens are clearly inferior for broiler production from the viewpoint of feed efficiency and sometimes for body weight at slaughter age (Table 2), it has been observed (unpublished data) that the performance of *Na na*⁺ and *na*⁺ *na*⁺ chickens do not show any disadvantage of the former when raised at a constant temperature of 25°C ± 1° from 4 weeks to a slaughter age (8 weeks). This trial concerned a total of 344 hatched chicks from a cross between Cornish males and *Na na*⁺ females from an experimental strain, the four groups corresponding to each sex and genotype being raised in separate identical floor pens. The mean 8-week average body weight for the *Na na*⁺ and *na*⁺ *na*⁺ genotype females was respectively 1407 and 1411 g, the corresponding feed efficiency from 10 to 56 days being 2.47 and 2.46. For *Na na*⁺ and *na*⁺ *na*⁺ males the mean 8-week weight was 1585 and 1598 g respectively, and feed efficiencies were respectively 2.34 and 2.33. None of these differences were significant. In these conditions, in the absence of any detectable disadvantage for the *Naked Neck* bird with respect to body weight and feed utilization, the only expected difference of economic significance at the broiler stage is the slight but consistent advantage found previously (Table 3) for slaughter yield and meat yield for the *Na na*⁺ birds. This gain can be compared with the cost of additional heating, depending on climatic and economic conditions and with the supposed loss in hatching rate associated with the *Na* gene. For average conditions in France the cost of heating at 25°C for 4 weeks may be estimated grossly as representing between 1 and 1.5% of the selling price of the broiler (Stevens, personal communication). The loss from a poorer hatching rate of *Naked Neck* chicks should be less than 1% of this price. Conversely, the gain from the improvement of yield of the eviscerated carcass can be estimated at a mean value of the order 1.8% and the more variable gain on meat yield is expected to be of the order 1 to 2% on the average. So it seems that in similar conditions to those in the experiments cited, the total balance is either close to zero or slightly positive, depending whether the effect on meat yield is taken into account or not. As suggested previously (Merat, 1981) this balance could be slightly improved if slaughter age is early so that the duration of additional heating is minimized.

For egg production, the data presented in table 5 show that when the

temperature does not exceed 20°C, the effect associated with the *Na Na* and *Na na*⁺ genotypes is complex. Feed efficiency deteriorated at fixed body weight and production mainly for the homozygote. On the other hand, the weight of adult hens, especially for the *Na Na* genotype, is appreciably reduced and in spite of this the mean egg weight is slightly increased. The result on total feed efficiency expressed as g feed per g egg is clearly unfavourable for the *Na Na* hens in a normal sized (*Dw*) population, but possibly not for the *Na na*⁺ genotype. Moreover, it must be noticed that for dwarf (*dw*) layers the deterioration of residual feed efficiency (at fixed body weight and production) associated with the *Na* gene is much more limited, so that the whole balance seems positive, or not unfavourable, at least for the *Na na*⁺ genotype (Bordas and Merat, 1984). Further work however should estimate in a more precise way the overall effect on feed efficiency in a dwarf stock and ascertain whether there is any harmful effect on shell strength for the *Naked Neck* birds in temperate conditions.

Conclusions More research is needed to establish in greater detail the environmental conditions in which the *Naked Neck* gene may be beneficial, for either broiler or egg production. In both cases, the economic interest in breeding “*Naked Neck*” duplicates of commercial parental lines would depend on the extent of the possible area of use for the derived crosses. This breeding work, incorporating the gene into a line followed by repeated backcrossing to the commercial line, would be facilitated by the ease of identification of the homozygous and heterozygous genotypes for the *Na* gene. Previously mentioned results indicate that, for broiler production a cross devised for hot climates, including one *Naked Neck* parent line, might also be used in temperate conditions with early slaughter and with the cost of additional heating to around 25°C. For egg production a *dwarf Naked Neck* layer for predominantly hot areas might combine the advantage of the *Na* gene in these conditions and that associated with the *dw* gene according to Horst and Petersen (1979) and Merat *et al.* (1974), but the use of *dwarf Naked Neck* stocks for egg production in temperate conditions needs to be further investigated.

Such considerations will certainly not be decisive at present for the broiler industries in developed countries. They may deserve more attention in future in the context of specific climates and including egg traits and mortality but also if there were to be future plateauing of progress in the main selected traits.

Acknowledgements

A recent thesis by H. W. Rauen (1985) on effects associated with the *Na* gene confirms results exposed in the present paper, and it adds other information, particularly the effects of this gene on adult mortality at high vs. moderate temperature, and its effects on performance traits in a heavy vs. light strain.

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Summary

The genetic basis and dominance relationships of the *Naked Neck* gene and its geographical distribution in local populations are described. The associated effects found on growth performance, feed efficiency and body composition of broilers, on egg laying and egg traits, reproduction and viability are reviewed.

The possible interpretation of these effects is discussed for each trait. Concerning the potential usefulness of the *Naked Neck* gene in poultry production, present-day results show on the whole an encouraging perspective at ambient high temperature, either for broiler or for egg production. At low or moderate temperatures an obvious defect associated with the *Naked Neck* gene is a deterioration of feed efficiency, either for growth or for laying, but the results cited suggest that this defect may be suppressed by a more precise control of the environmental temperature and possibly, as concerns egg production, by combining the *Naked Neck* and the sex-linked dwarf genes.

Résumé

Après un rappel de la description, de la transmission génétique et des relations de dominance du gène *cou nu* ainsi que de sa distribution géographique dans des populations locales, les effets trouvés associés à ce gène sur les performances de croissance, d'efficacité alimentaire et de composition corporelle des poulets, sur la ponte et les caractéristiques des oeufs, la reproduction et la viabilité, ont été passés en revue. La possibilité d'interprétation de ces effets est discutée pour chaque critère. Concernant l'utilité potentielle du gène *cou nu* en production avicole, les résultats actuels montrent dans l'ensemble une perspective favorable à température ambiante élevée, soit pour la production du poulet, soit pour la ponte. A température basse ou modérée, un défaut évident associé au gène *cou nu* est une détérioration de l'efficacité alimentaire, tant pour la croissance que pour la ponte, mais les résultats cités suggèrent que ce défaut peut être corrigé par un contrôle plus précis de l'environnement, et éventuellement, pour la production d'oeufs, par la combinaison avec le gène de nanisme lié au sexe.

Zusammenfassung

DIE POTENTIELLE NÜTZLICHKEIT DES NA- (NACKTHALS) GENS FÜR DIE GEFLÜGELPRODUKTION (P. Mérat)

Der Vererbungsmodus und die Dominanzverhältnisse des Nackthals-Gens und seine geografische Verbreitung in lokalen Populationen werden dargestellt. Die festgestellten Zusammenhänge dieses Gens mit dem Wachstum, der Futterverwertung und der Körperzusammensetzung bei Broilern sowie mit der Legeleistung und Merkmalen des Eies, mit Reproduktion und Lebensfähigkeit werden beschrieben. Die mögliche Bedeutung dieser Wirkungen wird für jedes Merkmal diskutiert. Hinsichtlich der potentiellen Nützlichkeit des Nackthals-Gens für die Geflügelproduktion belegen neuere Ergebnisse insgesamt eine aussichtsreiche Perspektive unter Bedingungen höherer Außentemperaturen, sowohl für Mastgeflügel als auch für die Eierzeugung. Bei niedrigen oder mäßigen Außentemperaturen sind offensichtliche Nachteile mit dem Nackthals-Gen verbunden, wie eine Verschlechterung der Futterverwertung sowohl beim Wachstum als auch in der Eierzeugung, aber die verfügbaren Ergebnisse deuten auch daraufhin, daß dieser Nachteil durch bessere Kontrolle der Umgebungstemperatur und möglicherweise durch Kombination des Nackthals-Gens mit dem Gen für geschlechtsgebundenen Zwergwuchs verhindert werden kann.

Resumen

LA UTILIDAD POTENCIAL DEL GEN NA (CUELLO PELADO) EN LA PRODUCCIÓN AVÍCOLA. (P. Mérat)

Se describen la base genética y las relaciones de la dominancia del gen Na (cuello pelado) con su distribución geográfica en poblaciones locales. Se revisan los efectos asociados encontrados sobre el crecimiento, la eficiencia del alimento y la composición corporal de broilers, sobre la puesta de huevos y trates de huevos, reproducción y mortalidad. Se discuten las posibles interpretaciones de estos efectos en cada trate. En cuanto a la utilidad potencial del gen Na (cuello pelado) en la producción avícola, los resultados de hoy día muestran un buen perspectiva a una temperatura ambiental alta, para producción de broilers y para la producción de huevos. a temperaturas bajas o moderadas un defecto obvio asociado con el gen Na (cuello pelado) es una empeoración de la eficiencia de alimento, o para el crece o para la puesta, pero los resultados citados sugieren que este defecto puede ser suprimido por medio de un control más preciso de la temperatura ambiental, y quizás, en cuando a la producción de huevos, por medio de la combinación de los genes para Na (cuello pelado) y enanismo ligado al sexo.

ПОТЕНЦИАЛЬНОЕ ЗНАЧЕНИЕ ГЕНА ГОЛОШЕЕСТИ ("NAKED NECK") В ПТИЦЕВОДСТВЕ (П. Мера)

Проводится взаимосвязь между генетической основой и доминантностью гена "Naked Neck" (голошеести) и географическим распределением птицы этого гена среди местных популяций. Рассматриваются тесно связанные воздействия между показателями роста птицы, оплатой корма, структурой тела бройлеров, яйценоскостью и качеством яиц, воспроизводством и жизнеспособностью. Возможное объяснение этих воздействий дается по каждому признаку. Что касается потенциальной пользы от гена голошеести в птицеводстве, существующие результаты исследований свидетельствуют в целом о перспективности влияния высокой температуры воздуха в среде обитания птицы как для бройлеров, так и для кур-несушек. При низкой и средней температуре очевидным недостатком, связанным с геном голошеести является повышение оплаты корма как для молодой птицы, так и для кур-несушек. Однако результаты свидетельствуют о том, что этот недостаток может быть устранен более точным контролем температуры окружающей среды и возможно в отношении кур-несушек сочетанием генов голошеести с генами карликовости.

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