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EFFECTS OF VARIOUS MELATONIN TREATMENTS ON SUMMER WOOL PRODUCTION IN ANGORA RABBITS.

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Introduction

Angora rabbits as most mammals living in temperate and cold climates show seasonal variations in coat composition and structure so that a thick long coat in autumn and winter is observed and a thin flat coat in summer. The spring coat is intermediate (Rougeot and Thébault, 1983). These seasonal variations of coat growth mainly concern the number of secondary derived hair follicles per hair follicle group (Rougeot et al, 1984) despite the longer growth period of Angora hair and the inducing effect of plucking every 14 weeks on hair follicle activity (Chase, 1954). The length and diameter of the three types of hair are also modified (Rougeot and Thébault, 1983). As a result, weight of Angora fleece which is maximal in autumn and winter decreases by 25 % in summer. The spring fleece weight is intermediate (Rougeot and Thébault, 1983).

It has been known for several decades that these seasonal variations in coat growth are regulated by photoperiodism (Bissonnette, 1935). If the neuro-endocrine mechanism controlling this photoperiod-dependent function is poorly understood, it has been clearly demonstrated that use of melatonin implants induces the formation of winter coat in weasel (Rust and Meyer, 1969), Djungarian hamster (Hoffmann, 1973), mink (Allain and Rougeot, 1980) and rabbit (Boyd, 1985).

In Angora rabbits use of melatonin implants throughout summer pelage growth prevents the decrease in summer wool production and results in a fleece weight similar to that of the autumn and winter by increasing hair follicle population and down length without any modifications of the other hair components (Rougeot et al, 1986).

It has been shown that regeneration of hair follicle population is achieved 2 weeks after plucking and that maximal hair growth rate is reached 3 weeks later (Thébault, 1977). So, is it necessary to maintain melatonin exposure throughout summer hair growth ? Moreover, a dose-dependent effect of melatonin on summer wool production has been suggested (Rougeot et al, 1986).

The purpose of this investigation was to measure this dose-dependent effect and evaluate effects of a short melatonin exposure using either subcutaneous implant or oral administration on summer wool production in Angora rabbit.

Materials and methods

Animals. The investigations were carried out in 1985 (Exp. 1) and 1987 (Exp. 2) with adult female French Angora rabbits (>1-year old). Animals were kept on straw litter in individual hutches in a closed building with artificial lighting regulated by a photoelectric system according to the natural photoperiod (45°North). Temperature was not accurately controlled but varied within the same limits for all rabbits. Does were fed with a standard diet of Angora rabbit pellets supplying 17% crude protein and 16% crude fibre. In order to prevent formation of trichobezoards a weekly rationing of the feed distributed over 6 days was applied (Rougeot and Thébault, 1977) throughout the 3-month pelage growth, so that each doe received each week 1300g, 1150g and 1000g, respectively during the first, second and last month. Water was available ad libitum.

Experiment 1. Fifty-six females were randomly divided into 4 groups according to their winter wool production. The day of spring wool harvest between May 8 and June 5, three groups were treated with melatonin (Fluka, Bucks, Switzerland) implants placed subcutaneously on the flank. The implants included 40 mg melatonin placed in a 5 cm-long Silastic tube (n°602-235; i.d. 1.47mm, o.d. 1.96 mm; Dow Corning Corp., Midland, Michigan, USA). One implant was deposited in the panniculus adiposus of the right flank skin in each animal in groups 1A (N = 14) and 1C (N = 14). In the same manner two implants were placed in each animal of group 1B (N = 14): one in the right flank and the other in the left one. Melatonin implants were removed 6 weeks later in group 1C and 14 weeks later in groups 1A and 1B. Group 1D (N = 14) served as control. Fourteen weeks after the day of spring wool harvest, all does were plucked and fleece weights registered.

Experiment 2. Forty-eight females were randomly divided into 3 groups according to their winter wool production. The day of spring wool harvest in May two groups were treated with melatonin. Each animal of group 2A (N = 16) received a 5 cm-long silastic implant containing 40 mg melatonin in the panniculus adiposus of the right flank skin. Six weeks later implants were removed. In group 2B (N = 16) each animal received each day at 14.00 hours for 6 weeks 1 mg melatonin adsorbed onto food pellets. Group 2C (N = 16) served as control. During the 6 weeks following the day of spring wool harvest all does were fed each day at 14.00 hours with 200g of the standard diet. Thereafter and until the end of the experiment, the usual week rationing of feed was applied. Five weeks after spring wool harvest skin samples of 1/3 cm2 were taken from the back by biopsy with a circular trephine. The skin pieces were treated according to the classical histological methods (Rougeot and Thébault, 1983). Then hair follicle population was determined using a projection microscope. The number of central primary hair follicles (PC) which produced bristle was counted as well as the number of lateral primary follicles (PL) which produced awn and secondary follicles (S) which produced down. The ratio (PL + S)/PC exactly expresses variations in population of derived hair follicles (Rougeot and Thébault, 1983). Fourteen weeks after the day of spring wool harvest does were plucked, fleece weight measured and lengths of bristle and down directly determined on a back stapple.

Statistical analysis. A two-way analysis of variance was performed using randomised blocks according to the ANOVA procedure of GENSTAT (Nelder, 1975). Differences between experimental groups were tested using the method of the least significant difference.

Results

Experiment 1. Weights of Angora wool (Table 1) obtained in summer in melatonin treated groups were significantly higher ($p < 0:05$) than in the control group: 11.5, 10.6 and 13.0% respectively for groups 1A, 1B and 1C. But no difference was observed whatever melatonin treatment.

Table 1: Summer Angora wool production (mean ±SEM) in four groups (exp. 1) of does treated as follow: Group 1A: one melatonin implant for 14 weeks. Group 1B: two melatonin implants for 14 weeks. Group 1C: one melatonin implant for 6 weeks. Group 1D: control.

	Group 1A	Group 1B	Group 1C	Group 1D
Summer wool production (g)	262.1 ±8.8	260.0 ±10.4	265.5 ±10.3	235.0 [a] ±6.9

(a) $p < 0.05$

Experiment 2. Weights of Angora wool (Table 2) obtained in summer in melatonin treated groups (oral or implant) were significantly higher ($p < 0.01$) than in the control group: 11.2 and 14.4%, respectively for groups 2A and 2B.
Hair density (Table 2) observed in summer in melatonin treated groups were significantly higher ($p < 0.001$) than in the control group: 23.7 and 29.2%, respectively for groups 2A and 2B.
However whatever the way of melatonin administration no statistical difference was observed as well on fleece weights as on hair density. Moreover lengths of bristle and down were not modified by any treatment.

Table 2: Summer Angora wool production and fleece characteristics (mean ±SEM) in three groups (exp. 2) of does treated as follow: Group 2A: one melatonin implant for 6 weeks. Group 2B: daily at 14.00 hours and for 6 weeks each doe received 1mg melatonin adsorbed onto food pellets. Group 2C: control.

	Group 2A	Group 2B	Group 2C
Summer wool production (g)	280.4 ±7.3	288.3 ±9.1	252.1 (a) ±8.4
Length of bristle (mm)	100.9 ±1.5	103.3 ±2.2	104.0 ±1.7
Length of awn (mm)	60.0 ±1.5	61.0 ±1.1	58.3 ±1.3
Hair density (PL + S)/PC	63.1 ±2.4	65.9 ±2.4	51.0 (b) ±0.6

(a) $p < 0.01$; (b) $p < 0.001$

Discussion

As shown in a previous work (Rougeot et al, 1986), the use of melatonin implants in Angora rabbit throughout the summer pelage growth significantly increase the fleece weight obtained in summer and hair follicle population, but was without effects on hair length. In the control group, the fleece weight obtained in the summer was 10 to 15% lower than in treated groups. This difference was similar to that usually observed between a summer and a winter production in our French Angora rabbit strain (Thébault and Rochambeau, 1988).

The use of either one or two implants per animal throughout the summer pelage growth as well as short length exposure (6 weeks) to melatonin did not modify the response to melatonin treatment. These findings suggest that 1) there is no dose dependent effect of melatonin opposite to the previous study (Rougeot and Thébault, 1986) and, 2) a 6-weeks exposure of melatonin is sufficient to prevent the decrease in summer wool production. But such results cannot explain the mode of action of melatonin. However, 6 weeks after plucking when melatonin treatment stops, only regeneration of hair follicle population and the first third of hair growth are achieved (Thébault, 1977). So it can be concluded that melatonin could act rather on hair density than on hair growth. The role of secondary derived hair follicles in seasonal coat changes (Rougeot et al, 1984) might confirm such hypothesis.

As a short length exposure to melatonin is sufficient to prevent the decrease in summer wool production, oral administration of melatonin is a suitable way of administration as shown in sheep (Kennaway and Seamark, 1980; Symons et al, 1983). Moreover, this oral administration is in agreement with the daily rationing of feed in Angora rabbit which prevents the formation of trichobezoards (Rougeot and Thébault, 1977).

In conclusion a 6-week melatonin administration either by implanting a subcutaneous capsule or by feeding daily and starting on the day of spring wool harvest is sufficient to prevent the decrease in summer wool production. However, oral administration is the most suitable way of administration in Angora rabbits.

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During the course of two sucessive experiments using adult female Angora rabbits kept in a natural photoperiod, we examined how various melatonin treatments in May from the day of spring wool harvest could prevent the decrease in summer wool production. Treatments included one or two subcutaneous implants throughout the summer pelage growth (14 weeks), one subcutaneous implant during 6 weeks, and a 1-mg oral dose (at 14.00 hours) per female and per day for 6 weeks adsorbed onto food pellets. For each experiment a control group was also used. Results indicate that whatever the dose, duration and route of melatonin administration during summer pelage growth, treated groups showed a significantly higher fleece weight (> 12 %) than the control groups. Thus in Angora rabbits, a 6-weeks melatonin administration either by implanting a subcutaneous capsule or by feeding 1 mg daily during summer pelage growth is sufficient to prevent the decrease in summer wool production and results in a fleece weight similar to that of the autumn and winter.

EFFETS DE DIFFERENTS TRAITEMENTS A LA MELATONINE SUR LA PRODUCTION ESTIVALE DE POILS CHEZ LA LAPINE ANGORA.

Au cours de 2 expériences successives, des lapines Angora adultes, maintenues sous une photopériode naturelle, ont reçu en mai, le jour de la récolte de poils de printemps, divers types de traitements à la mélatonine dans le but de supprimer la chute estivale de la production de poils. Nous avons comparé à un témoin les effets de 4 types de traitements: soit 1 ou 2 implants sous-cutanés maintenus durant toute la période de croissance du pelage d'été (14 semaines), soit 1 implant sous-cutané maintenu pendant 6 semaines, soit une dose journalière de 1 mg mélangée à la ration alimentaire et distribuée vers 14 h durant 6 semaines. Il en résulte chez tous les animaux traités une augmentation significative de 12 p 100 de la production estivale de poils par rapport aux animaux témoins, quelquesoit la dose, la durée de traitement et le mode d'administration de la mélatonine durant la croissance du pelage d'été. Ainsi chez le lapin Angora, un traitement à la mélatonine, durant 6 semaines, administré sous forme d'implants sous-cutanés ou par voie orale est suffisant pour supprimer la chute estivale de la production de poils et obtenir en été une récolte de poils équivalente en quantité à celles d'automne et d'hiver.