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Seasonal Production Performance of Angora Rabbits under Sub-temperate Himalayan Conditions

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ABSTRACT : An experiment of one-year duration was conducted on sixteen adult male German Angora rabbits under sub-temperate Himalayan conditions, to assess the effect of seasons on their body weight, wool production and quality, plane of nutrition and the digestibilities of nutrients. The daily meteorological attribute *viz.* minimum and maximum temperature; relative humidity and rainfall were recorded during winter (October to March), summer (April to June) and rainy (July to September) seasons. Biological parameters *viz.* body weight at the time of shearing, wool yield of individual rabbit, quality attributes of wool, fortnightly dry matter intake, chemical composition of feed and fodder and digestibilities of nutrients were recorded. Average minimum and maximum ambient temperature during winter, summer and rainy seasons were 4.6±1.9 and 21.4±2.8; 13.6±2 and 30.3±2; and 20.0±1.4 and 31.0±1.8°C, respectively. The average relative humidity and total rainfall during winter, summer and rainy season were 69.5±2.9% and 74.7±21.8 mm; 58.6±2.2% and 38.1±18.1 mm; and 69±4.2% and 104.0±43.7 mm, respectively. The body weight of rabbits increased during all seasons, however, the maximum average daily weight gain of 3.47±0.1 g was observed during the rainy season. The wool yield differed significantly ($p\leq0.05$) among different seasons with highest (140.4±10 g) and lowest (108.5±6.9 g) during winter and summer, respectively. The wool yield during the rainy season was 123.3±5.2 g. The wool quality attributes revealed non-significant differences for staple length, fiber diameter, medulation percent, percent pure fibers and percent guard hairs. Plane of nutrition revealed significant ($p\leq0.05$) differences for concentrate intake. The concentrate intake was highest during winter (124.4±2.6 g) followed by summer (86.8±8.9 g) and rainy (80.7±11.8 g) seasons. The reverse trend was observed in roughage intake with significantly ($p\leq0.05$) lower intake during winter and highest during summer months. As a result total dry matter intake during different seasons was similar. Significant differences ($p\leq0.05$) were observed for digestibilities of crude protein, crude fiber, ether extract, acid detergent fiber and cellulose. Digestibility of crude protein was highest during winter whereas the digestibilities of crude fiber, ether extract, acid detergent fiber and cellulose remained higher during the rainy season. During the winter season, the dry matter used for producing 100 g of wool was substantially lower than during other seasons and was concluded to be the best season for production of Angora wool under sub-temperate Himalayan conditions. (**Key Words :** Angora, Nutrition, Production, Rabbit, Season, Wool)

INTRODUCTION

Angora rabbit wool production in a particular area, under conventional rearing system, is influenced greatly by climatic conditions, nutrition and management other than germplasm. An ideal ambient temperature for Angora rabbit rearing ranges between 15-25°C and a small fluctuation between maximum and minimum temperature could disturb their growth performance (Chiericato et al., 1992) and the wool yield and quality (Rochambeau and Thebault, 1990). Around 25-28°C of ambient temperature, rabbits required more digestible energy with decreased feed consumption (Lebas, 1983). The feed consumption reported to decrease by 30% at 30°C along with body growth (Matheron and Martial, 1981). Angora rabbits are reported to have special requirements with regard to avoidance of temperature stress, which involved a lack of heat protection after shearing on one hand and difficulty to lose the waste heat of metabolism due to long fleece on the other hand (Schlolaut, 1986). High temperature restrict food intake in Angora rabbits, which leads to reduction in hair growth and ultimately poor fiber yield. Where as, in cooler season, the fiber yield was higher due to increased density and length of fibers. Warmer climatic conditions favored for Angora rabbit production improves the balance between feeding costs and fiber value

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Table 1. Chemical composition of concentrate and roughage(s) in different seasons

Composition	Concentrate	Roughage		
		Winter	Summer	Rainy
DM	90.00	63.23±2.57	47.91±4.31	52.35±2.35
CP	17.76	9.88	7.27	6.55
CF	10.21	27.33	28.19	21.05
EE	3.36	2.70	2.29	2.91
Total Ash	8.8	7.41	9.40	11.14
NFE	59.87	52.67	52.84	51.80
ADF	24.70	39.40	41.05	36.06
Cellulose	19.30	36.06	35.51	31.93
Lignin	5.4	4.20	5.54	4.13

Dietary composition- maize-20, barley-20, rice-phak-25, sunflower cake-6, mustard cake-6, groundnut cake-6, soyaflakes-6, fish meal-4, molasses-5, mineral mixture-1 and salt- 1%.

(Stephen et al., 1979), however, the best productive performances have been achieved with a temperature between 15-20°C (Casamassima et al., 1988). Low environmental temperature affected the body fat deposition adversely as most of the energy was used for maintaining temperature homeostasis (Stephen, 1980). Temperate grasses compositionally with less lignification had better digestibility and higher nutritive values than the tropical grasses (Cheeke, 1987). Under sub-temperate Himalayan conditions, winter was found to be the best season for broiler rabbit production (Bhatt et al., 2002). However, information on the effect of different seasons on the biological performance of Angora rabbits under conventional rearing system, in sub-temperate Himalayan conditions are lacking and the present experiment was, therefore, undertaken using German Angora rabbits.

MATERIALS AND METHODS

An experiment was undertaken with sixteen adult Angora male rabbits to assess the effect of three major seasons on their body weight, wool production, wool quality and nutrient utilization. Three major seasons categorized were - winter (October-March), summer (April-June) and rainy (July-September). Daily meteorological data *viz.* minimum and maximum temperature (°C), rainfall (mm) and relative humidity (%) were recorded during the experimental period. Rabbit were kept individually, under similar housing and management conditions, in all wire mash cages of standard size inside the house having asbestos roof and wall made up to asbestos and chicken wire mesh. Each rabbit was fed a mash concentrate at 150 g/d consisting of maize-20, rice-phak-25, barley-20, sunflower cake-6, mustard cake-6, groundnut cake-6, soyaflakes-6, fish meal-4, molasses-5, mineral mixture-1 and salt-1. Seasonal grasses fed *ad lib* were mainly a mixture of *Festuca arundinacea*, *Lolium perenae*, *Trifolium repens*, *Paspalum spp.*, *Puereria thunbergiana*, *Panicum spp.* and *Setaria spp.* Roughage samples were collected fortnightly, dried and stored for their composition. The body weight and wool yield of rabbits were recorded at the time of shearing. Each animal was sheared manually, with scissors, by the same person, at 75 d of experimental feeding, during each season, and wool samples from dorsal region of rabbit were collected for quality evaluation. Wool samples were analyzed for staple length, fiber diameter, medulation, pure fiber and guard hair using Ermascope (Erma India, Chandigarh). At the 70th day of feeding, a digestibility trial of five days duration was conducted on four representative rabbits during each season. Feed, fodder and faeces were analyzed for proximate principles (AOAC, 1990) and fiber fraction (Goering and Van Soest, 1984). Statistically, the data generated were analyzed for analysis of variance (ANOVA) as per the method of Snedecor and Cochran (1994) and presented as mean±standard error.

RESULTS AND DISCUSSION

Meteorological attributes

The monthly minimum and maximum average temperatures during winter, summer and rainy seasons during the experiment ranged from 1.5 to 29.7°C, 9.5 to 32.8°C and 17.1 to 34.5°C, respectively. The average temperature during winter, summer and rainy season were 13.8±2.9, 23.2±3.0 and 24.3±3.3°C respectively. The average relative humidity and total rainfall during these periods were 69.5±3.0 percent and 73.5±22.2 mm; 58.1±1.5 percent and 25.7±5.7 mm; and 73.1±0.04 percent and 146.0±21.0 mm, respectively.

Chemical composition of concentrate and roughages

The chemical composition of grasses fed to rabbits during different season is given in Table 1. The dry matter content of grasses fed during winter was highest (63.23±2.57%) due to the high proportion of dry hay, while it was lowest (47.23±4.31%) during summer season due to the availability of succulent lush grasses. The protein content of the roughage was highest (9.88%) during winter

Table 2. Body weight, wool yield and plane of nutrition during different seasons

Parameters	Winter October-March	Summer March-July	Rainy July-October
Initial body weight (kg)	2.68±0.08[a]	2.82±0.08[b]	2.97±0.05[c]
Final body weight (kg)	2.82±0.08[a]	2.97±0.05[b]	3.23±0.03[c]
Gain/day (g)	0.94±0.04[a]	1.0±0.05[a]	3.47±0.10[b]
Wool yield (g per shearing)	140.4±10.0[c]	108.5±6.9[a]	123.3±5.2[b]
Wool yield (g/kg $W^{0.75}$)	63.5±2.4	47.9±2.1	48.9±1.9
Plane of nutrition			
Concentrate intake (g/d)	124.4±2.6[b]	86.8±8.9[a]	80.7±11.8[a]
Roughage intake (g/d)	24.0±1.5[a]	71.3±8.1[b]	69.5±5.9[b]
Dry matter intake (g/d)	148.4±4.0	158.1±16.9	150.2±17.6
Proportion of concentrate (%)	83.8	54.9	53.7
Proportion of roughage (%)	16.2	45.1	46.3
Dry matter used/100 g wool produced (kg)	7.92	10.93	9.14

Values with different superscripts in a row differ significantly (p≤0.05).

followed by summer (7.27%) and lowest (6.55%) during rainy season. Composition of concentrate (Table 1) revealed 17.76% crude protein, 10.21% crude fiber, 3.36% ether extract, 8.8% total ash, 59.87% nitrogen free extract, 24.7% acid detergent fiber, 19.3% cellulose and 5.4% lignin. All the nutrients present in the diet (concentrate+roughage) were within the permissible limits (NRC, 1977).

Biological performance and wool quality

The initial and final body weights and change in rabbit weights during different seasons are presented in Table 2. Significant (p≤0.05) difference among seasons was observed for all body weight in rabbits. The increase in body weight of rabbits was due to fattening, which occurred after attaining the reproductive age and was significantly (p≤0.05) higher during rainy than summer and winter seasons. This could be due to the reason that during winter the body fat reserves were used much for maintaining temperature homeostasis as compared to summer and rainy seasons. Contrary to these observations, Stephen (1980) reported decreased gain at higher (30°C) as compared to lower (5°C) environmental temperature. This difference could have been due to the reasons that fluctuation in environmental temperature was very high in former as compared to constant temperature in later experiment. The productive performance reported to improve in some way at 25°C and even a small fluctuation between maximum and minimum temperature disturbed the growth performance of rabbits (Chiericato et al., 1992). Bhatt et al. (2002) found winter season appropriate for the best feed: gain in broiler rabbit under sub-temperate Himalayan conditions. Significant (p≤0.05) differences were also observed in the wool yield per shearing of rabbits during different seasons (Table 2). The wool yield during winter was significantly (p≤0.05) higher than rainy followed by the summer season. These observations were in agreement with Rochambeau (1988), who reported winter harvest more productive than summer ones. Xu et al. (1992) reported that with an increase or decrease of ambient temperature by 1°C, the wool output of Angora rabbits reduce or increase by 4.244 g. Schlolaut (1987) also reviewed low wool yield in Angora rabbits at 30°C as compared to 5°C with elucidation that low feed intake at high temperature reduces hair growth and consequently decreased wool yield. However, it was not the case in this experiment as the total dry matter intake during different seasons was almost equal. Temperature, relative humidity and rainfall appeared to be the major variables, but not much of the differences were observed in roughage sources fed during these periods. Rochambeau and Thebault (1990) reported maximum wool production for autumn and winter, and minimum for summer season and these variations in coat growth are reported to regulate by photoperiodism (Allain and Thebault, 1988). Wool quality attributes (Table 3) revealed non-significant differences for staple length, fiber diameter, medulation percent, pure fiber and guard hair during different seasons. However, fiber diameter and pure fiber were lower in winter and increased during summer and rainy seasons. Herrmann et al. (1996)

Table 3. Wool attributes during different seasons

Parameters	Winter	Summer	Rainy
Staple length (cm)	5.18±0.12	5.10±0.12	5.37±0.13
Fiber diameter (micron)	13.50±0.35	13.96±0.30	14.30±0.27
Medulation (%)	90.10±0.84	89.39±0.87	88.55±1.23
Pure fiber (%)	6.28±0.87	7.06±0.97	7.78±1.46
Guard hair (%)	3.67±0.55	3.33±0.43	3.72±0.44

Table 4. Digestibility coefficients (%)of nutrients in different seasons

Nutrient	Winter	Summer	Rainy
DM	64.1±1.5	58.7±2.4	66.8±3.3
CP	77.8±1.1 [b]	67.2±2.2 [a]	71.1±2.9 [a]
CF	12.5±3.5 [a]	31.7±5.5 [b]	45.0±7.4 [c]
EE	54.3±3.9 [a]	59.4±1.7 [a]	70.4±6.7 [b]
NFF	73.7±1.4	69.0±1.7	75.0±2.2
ADF	37.9±3.1 [a]	39.8±2.4 [a]	47.8±4.7 [b]
Cellulose	35.3±2.4 [a]	39.7±3.4 [a]	51.9±4.5 [b]

Values with different superscripts in a row differ significantly ($p\leq0.05$).

reported that Angora fiber yield and quality are influenced by environmental conditions. Doppler et al. (1984) observed lower wool yield in Angora rabbits at higher environmental temperature and was related to the higher fiber density and the longer fiber in colder climates compared to warmer ones. However, the extent of dependence of this effect on the temperature alone or on other environmental components was unknown (Herrmann et al., 1996). Rochambeau and Thebault (1990) reported longer bristles and dawn during winter than summer clipping. Allain and Thebault (1988) reported seasonal variation with thick, long coat in autumn and winter and thin flat coat in summer.

Plane of nutrition

Plane of nutrition revealed significant ($p\leq0.05$) differences among seasons for concentrate and roughage intake. The daily concentrate intake was highest during winter and lowest in rainy season whereas the opposite trend was observed for roughage with lowest intake during winter and highest during summer followed by rainy season. Therefore, the differences in total dry matter intake were non-significant among three seasons. The highest concentrate intake with lowest roughage intake during winter months was possibly due to feeding of dry hay having low palatability. Minimum requirement of dietary fiber is no doubt of importance in maintaining the health status and growth performance of rabbits (Ying et al., 2007). Palatability of grasses remains highest in early succulent stage and reported to decrease with the maturity of grasses (Church, 1986). The higher roughage intake during summer and rainy months was due to feeding green succulent roughage having higher palatability. Bhatt et al. (2002) observed similar trends in broiler rabbits under sub-temperate conditions. Digestibility coefficients of nutrients in Angora rabbits are presented in Table 4. Significant ($p\leq0.05$) effect of season on the digestibilities of crude protein, crude fiber, ether extract, acid detergent fiber and cellulose was observed. The digestibility of crude protein was highest during winter than summer and rainy seasons. It was due to high intake of concentrate having highest nutritive value. The observations were in agreement to those reported in broiler rabbits (Bhatt et al., 1996) that decreased level of concentrate decrease protein digestibility. The digestibilities of crude fiber, ether extract, acid detergent fiber and cellulose were lowest during winter and highest during rainy season. The results indicate that during winter rabbit satisfied its energy needs by consuming much of concentrate and could not utilize roughage efficiently due to poor nutritive value. Rabbit satisfies its requirement mostly from non-fiber component of diet as the digestive tract of the rabbit is adapted to the utilization of fibrous feeds but not to the use of fiber itself (Cheeke, 1983). Grasses fed during summer and rainy season were either premature or partially mature and therefore, had better digestibilities of crude fiber, acid detergent fiber and cellulose. The higher digestibility during rainy season as compared to summer season was due to the differences in composition of roughage consumed during these two seasons. Supharoek et al. (2008) also reported significant effect of foliage sources on the digestibility of nutrients in broiler rabbits. The roughages during summer had higher crude fiber, acid detergent fiber, cellulose and lignin and therefore, low digestibilities as compared to rainy season. Xiccato (1998) reported that in non fat added diet the fat was strictly associated with cell walls and therefore, the digestibility of fat was related with the digestion of cell walls means fiber digestibility and possibly holds true in our findings as well. The digestibilities of acid detergent fiber and cellulose had trend similar to the crude fiber. The acid detergent fiber and cellulose digestibilities were higher during rainy season due to low contents of acid detergent fiber, cellulose and lignin in roughage. Similar results were reported earlier in broiler rabbits (Bhatt et al., 2002). Xiccato and Cinetto (1988) also reported low fiber digestibility at high nutritive level, which were confirmed in broiler rabbits (Bhatt et al., 2005). No significant difference for the digestibility of dry matter was observed.

CONCLUSIONS

From this study it can be concluded that under sub-temperate Himalayan conditions, seasons significantly affect the forage composition. Also significant effects of seasons on wool yield and concentrate intake in Angora rabbit were observed. Digestibility of crude protein was higher whereas that of crude fiber, ether extract, acid detergent fiber and cellulose was lower during winter season and was influenced significantly by different seasons. Total dry matter intake, NFE digestibility and wool quality attributes were not affected significantly by different seasons. Dry matter used for producing 100 g of wool was lower during winter than other two seasons indicating winter as the best season for Angora rabbit wool production under conventional management system in sub-temperate Himalayan conditions.

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