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MATCHING INGESTIVE BEHAVIOUR OF GOATS TO LOCAL FEED RESOURCES

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Abstract. This study was undertaken to find ways of reducing the time taken by goats to begin to eat an edible feed that they have not previously encountered. Experiment 1 demonstrated that the time taken for goats (7-8 months old) to ingest an unfamiliar feed (rice straw) was shorter (4 days) when it was first offered to them in the presence of familiar positive cues (the odor or flavor of juices extracted from previously eaten, nutritionally beneficial grasses), than if it was offered in the absence of such cues (10 days). In contrast, when the feed was offered in the presence of the odor of parasitised goat feces, the time to first ingestion was extended to 20 days. Experiment 2 showed that when six-month old goats were exposed to feeds they had not experienced previously (rice straw or rice bran) they did not ingest these feeds in less than 7 days. However, they commenced ingesting these feeds immediately if they had been exposed to them, prior to weaning, in the presence of their mother or another adult goat. Application of the principles of feeding behavior, as illustrated by the present studies, to goats in Vietnam may improve their production, especially when diets are changed frequently and include both familiar and unfamiliar materials.

Keywords: Behavior; Diet selection; Flavor; Neophobia; Social facilitation; Goat.

1 Introduction

Production of animals that are hand-fed or kept in feedlots, or during periods of drought, is likely to be sub-optimal if they are slow to begin ingesting new feeds after their diet is suddenly changed. In many vertebrate species, neophobia is common when individuals are confronted with unfamiliar but edible feeds. It is probably the basis of a protective process that allows animals to avoid toxicosis while learning from the post-ingestive consequences of eating a new and potentially toxic feed (Corey, 1978). Ruminants, for example, are often reluctant to eat feeds if they have not experienced them previously (Provenza and Balph, 1990; Nolan et al., 1995; Tien et al., 1999).

One way to reduce the effects of neophobia is to add familiar dietary cues to the novel feed, e.g. extracts from grasses with a familiar odor or flavor (Tien et al., 1999). Another method is to use mothers or other experienced animals to train young animals

so that they will recognise feeds that they encounter later in life (Lobato et al., 1980). However, there appear to be no studies with goats to investigate these possibilities.

The present study was designed to test if goats would more quickly begin to eat an unfamiliar feed if it was offered in association with either the odor or flavor of familiar native grasses. We also wished to test if the goats would exhibit less neophobia after weaning if they had participated in a pre-weaning training program designed to allow them to experience the same feed while with their mothers or with experienced adult goats.

2 Materials and methods

There were two experiments. In Experiment 1, we examined the effect of the addition of familiar grass odor and flavor to unfamiliar feed materials as a means of overcoming feed neophobia and poor acceptance of those feeds and in Experiment 2, we investigated the effect of training, in the pre-weaning period, goats about feeds they are likely to encounter after weaning, using their mothers and experienced adults as teachers.

Experiment 1

This experiment was carried out to test how quickly goats would commence to eat a novel test feed, i.e. rice straw. Twenty-four Bachthao goats (7-8 months of age and approximately 35 kg) were used for the experiment.

The rate of ingestion of rice straw by individual goats was determined during a 15-min test when it was offered, as a novel feed, in the presence or absence of a familiar flavor or odor of native grasses, or in the presence of feces from a goat infected with internal nematode parasites. Six of the goats were randomly allocated to each of 4 treatments, viz. **Control** - rice straw offered with no odor or flavor additives; grass odor (**GO**) - rice straw offered in the presence of grass odor; flavor group (**GF**); rice straw offered mixed with juice extracted from familiar grass; fecal odor group (**FO**) - rice straw offered in the presence of odor of parasitised goat feces.

Odor and flavor preparation

Three grasses (*Cyperus rotundus L., Cynodon dactylon (L.) Pers,* and *Brachiaria distatachya (L.) Stapf*) identified by farmers as being familiar and readily eaten by the goats were used in Experiment 1. Early each morning before the testing period, about 500 g of each of these grasses was harvested. The grasses were mixed and then squeezed using a machine traditionally employed in the village for extracting sugar cane juice. Water (300 ml) was added to the mulched residues that were then wrapped in mosquito netting and compressed to extract a solution of grass juice.

Fresh feces (3 g) from a parasitised goat were collected every morning before the test period and used in a moist state throughout the test.

Testing procedures

Testing was done in a yard large enough (1.5 m x 3.0 m) to hold 6 goats and to accommodate two feeding troughs. Two fenced paths were constructed between the yard and a covered pen where animals were held overnight. These paths enabled two groups of six goats to be guided separately to the two testing yards and then tested simultaneously. The two wooden feeders in each yard were 1 m in length and provided enough space for 3 animals to eat side by side in separate compartments. Bamboo lattice was used to make the feeder floor (0.5 m above the ground), and also the sides and compartment dividers. The design of the feeding area allowed the goats to see each other throughout the test period.

Before offering rice straw during the test, all animals were exposed to the testing environment and routine for 3 days. Sham testing was done using native grasses that were familiar to the goats, but were not the source of the grass juice solution to be used later. After an overnight fast in the holding pen, all goats were offered chopped rice straw that was placed on a bamboo lattice feeder base and intake was measured over 15-min test period. For two of the treatments, 40 ml of grass juice (**GO** group) or 2 g of feces (**FO** group) were placed in containers placed 3 cm below the feeder base. The mesh size of the feeder base prevented the rice straw from falling through while allowing the odor to permeate the feed. For the **GF** group, 50 ml of the grass extract was mixed with 1 kg of the rice straw before it was placed on the bamboo base.

The animals in the **GO** and **GF** groups were tested from 06.00 to 06.30 h each day. Six goats in the **GO** group were placed in the yard with feeders 1 and 2 while the remaining six goats (**GF** group) were placed in the yard containing feeders 3 and 4. The goats in the **FO** and control groups were similarly tested at 07.00 to 07.30 h. The test period for each treatment was kept constant to avoid errors. Each morning after the tests were completed, the feed containers were thoroughly cleaned, rinsed and air-dried and the goats were put out to graze together for about 8 h. The morning tests were continued for 40 days.

Experiment 2

Eighteen Bachthao goats at 3 months of age were placed at random into three groups (n=6 per group) and tested at 6 months of age to determine their willingness to ingest chopped rice straw and rice bran after having had no previous experience of these feeds (untrained group) or having been given the opportunity to learn about these feeds before weaning while with their mothers or with other adult goats. The treatments groups were: **Control** - not trained before weaning (the traditional practice) nor at any time after weaning up to the commencement of testing; **LM -** trained before weaning by offering them chopped rice straw and rice bran for one week with their mothers (n=4), **LA -** trained before weaning by offering them chopped rice straw and rice bran for one week with 4 experienced adult goats that were not their mothers. There were 6 young

animals in the Control, **LM** and **LA** groups with their mothers, i.e. some mothers had twin offspring with them.

Training young goats before weaning

The training yards were large enough (4m × 3m) to hold 10 goats (6 young goats with 4 adult goats to act as trainers) and to accommodate 2 feeders, each capable of allowing 5 animals to eat side by side. Two fenced paths were constructed to guide goats from the covered pen where they were held overnight to the two 'training' yards.

At 3 months' of age, all young goats in the **LM** and **LA** groups were exposed daily to the training environment with their mothers or other adult goats in order to experience and learn how their instructors accepted and ingested rice straw and rice bran: the young animals had the opportunity to ingest these supplements, but none did so.

The details of training were:

- After an overnight fast in the holding pen, 6 young goats in the **LM** group, i.e. 4 mothers and 6 offspring, and 6 young goats in the **LA** group with 4 experienced goats (teachers) were offered supplements of chopped rice straw and rice bran in a 1:1 ratio (w/w).
- The goats were exposed to both feeds simultaneously for 15 min each morning for 7 d. After training, the animals were allowed to graze together for about 8 h and then returned to the yards where they were again held over night.

After this training week and after weaning, all the goats grazed together on common land in the village for 8 hours a day. They ate grasses and leaves during the three months between the training week and the start of testing, but no rice straw or rice bran as would normally occur according to the traditional practice in this village.

Testing after weaning

At 6 months of age, the goats in the three groups were offered either rice straw or rice bran for 15-min each morning for 7 days and intake was recorded. The goats were exposed to the testing environment and routine for 3 days before actual testing was started. This sham testing was done using native grasses that were familiar to and previously ingested by these goats.

From 6.00 to 6.30 h, after an overnight fast in the holding pen, six young goats in the **LM** group were placed in the yard containing feeders 1 and 2 while six animals in the **LA** group were placed in the yard containing feeders 3 and 4. From 7.00 to 7.15 h, six of young goats in the control group were placed in the yard containing feeders 1 and 2 for testing.

Statistical analysis

Analysis of variance was performed using the general linear model (GLM)

procedure of Minitab version 12 (1998). Comparisons with a confidence level of 95 % were used to determine the effects of behavioral treatments between groups.

3 Results

Experiment 1

Goats in the control group did not eat any rice straw until Day 9. Animals in the odor and flavor groups ingested nothing for the first 4 days but ingested a small amount of rice straw on Day 5 (see Fig. 1 and Table 1). Animals in the **FO** group rejected the rice straw completely until Day 20 after which small amounts of straw were eaten but the intake of individuals in this group continued to be low relative to goats in the other groups (generally less than 15 g/day).

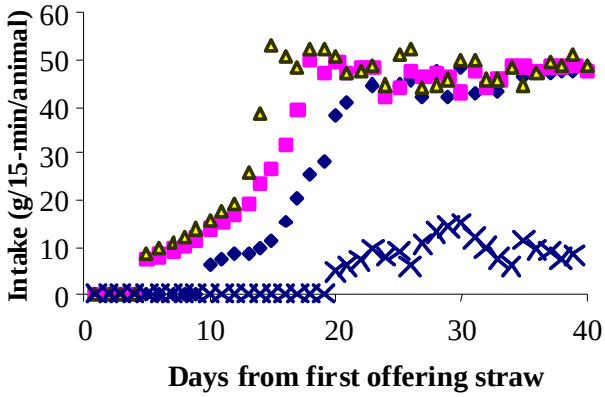


Fig. 1. *The intake (g/animal) during a daily 15-min test of goats being offered rice straw for the first time from Day 0 with no cues (Control, 6), or with the odor of familiar grass juice nearby (GO,■), or with the flavor of familiar grass juice mixed with the straw (GF, Δ) or with the odor of feces from a parasitised goat nearby (FO, X). Results are shown as means for six goats per treatment.*

Table 1. *Intake (g/animal) of rice straw of the goats in a 15-min test during 40 consecutive days. The rice straw contained either added grass flavor (GF), grass odor (GO), fecal odor (FO) or without additive (control). Results are shown as means ± SD for six goats per treatment.*

Days	Treatment			
	GF	GO	Control	FO
1-4	0	0	0	0
5	8.5 ± 1.7	7.6 ± 1.4	0	0
6	9.8 ± 1.8	8.2 ± 1.3	0	0
7	10.8 ± 0.7	9.3 ± 0.7	0	0
8	12.1 ± 1.8	10.2 ± 1.8	0	0
9	14.0 ± 1.1	11.9 ± 1.7	0	0

10	15.6 ± 2.0	14.2 ± 1.1	6.2 ± 1.1	0
11	17.8 ± 2.7	15.2 ± 1.6	7.3 ± 1.3	0
12	19.2 ± 2.1	16.8 ± 1.8	8.5 ± 1.2	0
13	26.2 ± 3.1	19.5 ± 2.2	8.8 ± 1.3	0
14	38.2 ± 4.9	23.8 ± 2.1	9.6 ± 1.7	0
15	53.0 ± 5.2	26.5 ± 3.0	11.5 ± 1.7	0
16	50.5 ± 2.8	32.0 ± 4.5	15.5 ± 3.2	0
17	48.3 ± 4.2	39.2 ± 2.9	20.5 ± 3.8	0
18	52.2 ± 3.7	50.0 ± 3.0	25.3 ± 3.3	0
19	52.3 ± 3.8	47.0 ± 1.6	28.0 ± 5.8	0
20	50.5 ± 2.6	49.2 ± 4.4	37.7 4.9	0
21	47.7 ± 4.3	47.7 ± 4.2	41.2 ± 2.6	4.8 ± 1.5
22	47.2 ± 3.8	48.0 ± 4.7	48.0 ±3.3	5.8 ± 2.2
23	49.0 ± 4.1	48.2 ± 3.1	44.5 ± 3.5	7.3 ± 2.5
24	44.3 ± 4.9	42.3 ± 4.2	43.3 ±4.6	9.5 ± 1.7
25	51.0 ± 2.8	43.7 ± 4.6	44.8 ± 4.2	8.0 ± 3.2
26	52.8 ± 3.6	47.2 ± 1.8	47.5 ± 4.6	9.1 ± 3.8
27	43.8 ± 5.7	46.3 ± 3.3	42.2 ± 5.2	5.8 ± 2.5
28	44.2 ± 3.9	47.0 ± 3.8	47.2 ± 4.7	10.8 ± 2.2
29	45.3 ± 4.1	46.5 ± 6.2	42.3 ± 4.5	13.0 ± 1.9
30	50.2 ± 5.3	43.0 ± 4.3	48.2 ± 3.0	14.2 ± 2.9
31	50.0 ± 5.0	47.2 ± 3.5	42.8 ± 4.0	15.0 ± 1.7
32	45.5 ± 2.9	40.0 ± 4.8	43.8 ± 5.8	11.8 ± 3.3
33	45.8 ± 3.3	45.8 ± 4.9	43.5 ± 5.3	9.8 ± 4.0
34	48.2 ± 4.5	49.0 ± 3.6	48.8 ± 4.5	7.5 ± 1.2
35	44.5 ± 5.3	48.6 ± 3.9	46.3 ± 3.5	6.0 ± 1.5
36	47.0 ± 5.2	47.5 ± 3.9	46.5 ± 3.0	11.5 ± 2.4
37	49.5 ± 4.6	47.7 ± 2.3	46.8 ± 3.6	9.3 ± 2.8
38	48.5 ± 2.8	48.5 ± 3.4	47.2 ± 2.8	9.0 ± 2.1
39	51.5 ± 2.7	48.8 ± 1.9	47.5 ± 3.8	7.5 ± 2.8
40	48.7 ± 3.9	47.8 ± 3.7	48.0 ± 3.6	8.3 ± 2.3

During the first 18 days of consecutive exposure, goats in the odor group (GO) ate more supplement than those animals in the control group ($P < 0.01$) and achieved their highest intake (50 g) on day 18, in contrast, control goats took 23 days to achieve their highest intake (48 g). However, from day 22 to day 40, there was no significant

difference in intake between the odor group and the control group ($P > 0.1$).

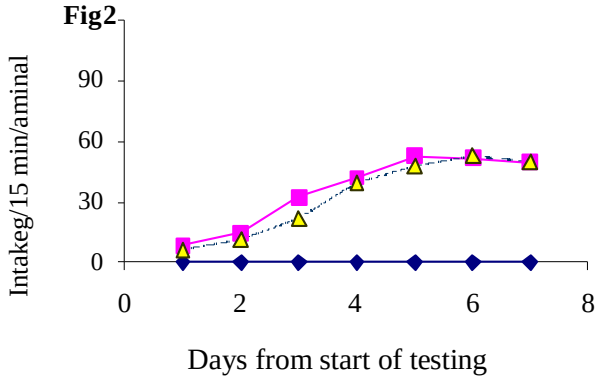
During the first 15 days of the test, animals in the flavor group (GF) consumed more supplement than did animals in the control group ($P < 0.05$). They achieved their highest intake (53 g) on day 15. However, from day 22 to day 40, there also was no significant difference in intake between this group and the control group ($P > 0.1$).

Maximum intake of novel feeds during testing occurred earlier in the flavour (taste plus odor) group than in the odor group ($P < 0.05$). Both these groups started eating more quickly than the group with no familiar, positive cues and therefore had higher mean intakes during the first 3 weeks of testing than the goats in the control group ($P < 0.01$). However, the intake eventually reached by the groups receiving familiar, positive cues did not differ significantly after about 3 weeks, whereas the intake of the group tested with the odor of faeces from parasitised goat was always much lower throughout the 40 days of testing.

Experiment 2

In Experiment 2, the goats in **LM** and **LA** groups were trained for only one week before weaning and then were not exposed to rice straw or rice bran until the start of testing at 6 months of age. At the start of the training, they appeared to avoid the rice straw but did warily sniff the rice bran suggesting that, even at this young age, they may have detected a familiar cue in bran that was not present in straw. During this training, the young goats saw their mother or other adult goats near to them ingesting rice straw and rice bran but did not eat these feeds themselves.

When tested at about 6 months of age, goats in Control group with no previous experience of either feed ate no rice straw over the 7 days of testing or started to eat small amount of rice bran on day 6 (Fig. 2 and Table 2). In contrast, by Day 7 the **LM** group and the **LA** group reached intakes of 53 g rice straw and 98 g rice bran, respectively (Figs 2 and 3). Exposure of a young goat to the test feed with its mother resulted in learning that persisted for at least 3 months and resulted in the more rapid acceptance of that feed. The effect of training with mother on subsequent acceptance of either test feed was higher than for similar exposure with other experienced adults ($P < 0.05$).



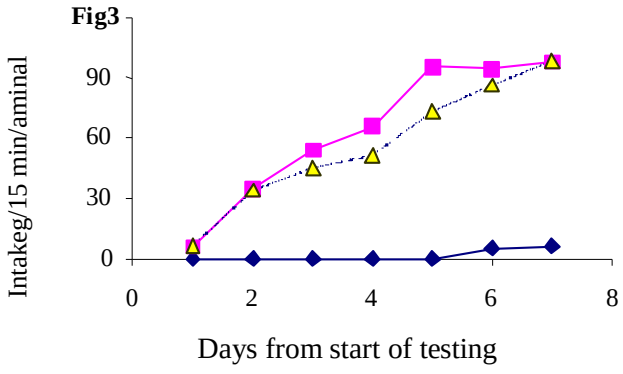


Fig. 2 and 3. *Intakes (g/animal) of rice straw (Fig. 2) and rice bran (Fig. 3) by six-month old weaned goats in the group with no previous exposure to rice straw or rice bran (control, 6) compared with young goats exposed, for one week, at 3 months of age to rice straw or rice bran, in the presence of their mothers (Δ) or experienced adults (+). Results are shown as means for six goats per treatment.*

Table 2. *Intake (g/goat) of rice bran or rice straw during a 15-min test. The goats either had no previous experience (control) or learned about the feedstuffs from their mothers (LM) or other adults (LA). Results are shown as means ± SD for six goats per treatment.*

Days	Treatment		
	LM	***LA***	***Control***
Rice bran			
1	6.0 ± 2.1	6.7 ± 3.3	0
2	34.8 ± 6.7	34.0 ± 5.7	0
3	54.0 ± 6.3	45.5 ± 5.1	0
4	65.8 ± 3.9	51.3 ± 4.0	0
5	95.3 ± 6.7	73.3 ± 6.1	0
6	94.2 ± 7.5	86.3 ± 6.5	5.3 ± 1.7
7	97.8 ± 6.0	98.3 ± 7.1	6.6 ± 1.8
Rice straw			
1	8.5 ± 2.1	6.3 ± 1.2	0
2	14.7 ± 2.4	11.5 ± 2.6	0
3	32.2 ± 4.2	21.8 ± 3.3	0
4	42.3 ± 3.8	39.5 ± 2.5	0
5	52.7 ± 4.3	47.7 ± 4.3	0
6	51.5 ± 4.2	52.6 ± 2.9	0
7	49.6 ± 3.9	49.8 ± 2.8	0

4 Discussion

Preference for a particular feed depends on recognition of salient odor or flavor or other cues based on previous experience of that feed, and also on conditioned associations between the cues that allow recognition of that feed and its post-ingestive effects (Provenza, 1996). As can be seen in Fig. 1, the intake of rice straw did not change significantly during the final period of training, and the goats appeared to completely overcome neophobia for rice straw after about three weeks (except in the case of the rice straw offered in the presence of odor of parasitised-goat feces). Apparently, the odor or flavor of native grasses did not affect the eventual intake of rice straw once animals had become familiar with the new feed, but rather it shortened the period for achieving the maximum intake. These results are similar to those obtained under similar conditions in Vietnam with sheep (Tien et al., 1999). Chapple et al. (1987) reported that sheep did not ingest cereal grain (an unfamiliar feed) for several days after being exposed for the first time to grain. They then commenced ingesting small quantities of grain and then rapidly increasing their intake over 2-3 days. Thus the inclusion of both familiar cues in association with rice straw or rice bran at the time when goats were first exposed to these feedstuffs enhanced intake in the short-term, presumably by helping to reduce neophobia, and would have generated higher growth rates in this period if the two feedstuffs combined were the sole source of nutrition. The shorter period to first acceptance of these unfamiliar feeds when presented in association with familiar, positive cues may be a result of stimulus generalization. This phenomenon has often been described in flavor aversion experiments that lead to subsequent avoidance of feeds but there is less evidence that animals achieve a flavor or odor preference by generalisation. Nevertheless, studies with lambs (Launchbaugh et al., 1997) and sheep (Tien et al., 1999), and the present study with goats provide evidence that preferences may also be promoted by cue association.

Evidence from Experiment 2 suggests that young animals learn to recognize new feeds and extinguish their neophobia for them if they share the experience of their dam or other adults eating those feeds. Studies in sheep showed that lambs that had experienced molasses-urea blocks 6 months earlier had higher intakes than similar lambs with no such experience (Lobato et al., 1980). Similarly, McDonald et al. (1988) found that Merino wethers that had experienced supplementation with pellets 16-18 months previously as suckling lambs in groups with their mothers, ingested more pellets than those that had never experienced the same supplements. Moreover, in the post-weaning period as young ruminants began to forage, those that were reared with their mothers learned to select appropriate feeds and avoided feeds containing toxins more quickly than lambs reared without their mothers (Mirza and Provenza, 1990). Social facilitation allows information about feeds to pass from an experienced animal to an inexperienced one, for example, from mother to offspring or from adult to young

(Lobato et al., 1980; Lynch et al., 1983). The present study suggests that information about feeds may be passed more quickly from mother to offspring than from other adults or peers. This might be the case because the dam and her offspring are more closely related and sensitivity to certain tastes (e.g. sweet and bitter compounds) is genetically mediated in human beings (Drewnowski and Rock, 1995). However, it is also possible that learning is enhanced by proximity of the offspring to mother who thereby becomes the principal demonstrator (Nicol, 1995), or because the offspring is already conditioned to cues passing from feed ingested by the dam to the offspring via the milk, or via other routes, with the result that the offspring is then more likely to accept new feeds that exhibit the same cues (Leon et al., 1977).

5 Conclusions

When goats are offered an unfamiliar feed, neophobia delays its acceptance and intake may be sub-optimal for periods of a week or more. However, the conjunction of familiar odors or flavors of native grasses with an unfamiliar feed will increase its rate of acceptance and shorten the interval between first exposure and first ingestion. The overall result will be that animals maintain a higher average feed intake under conditions in which feeds are frequently changed and are unfamiliar. Exposing young goats to feedstuffs in the presence of their mother or another experienced adult reduces their neophobia when diets are changed suddenly to include one of these feedstuffs. The overall effect is to reduce the period of sub-optimal intake when diets are changed and to increase production in the interim period.

The inclusion, as part of farm management, of training sessions for young animals using adults as demonstrators may be a useful addition to the agricultural practices of villagers in Vietnam, and may pave the way for a more efficient use of a variety of non-conventional feeds for ruminant production.

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