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Effect of roughage to concentrate ratio on performance and RFI of lactating crossbred cows

Jyoti Sumer Kajla[1], R.S. Grewal[2], Puneet Malhotra[3], J.S. Lamba[4], Simarjit Kaur[5], Jasmine Kaur[6]

[1]PG student [2,4]Professor [6]Assistant Professor, Department of Animal Nutrition, [3]Dairy Manager, Directorate of Livestock Farms, [5]Assistant Animal Gymnastic, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab 141004, India.

Keywords:

RFI;
Roughage to Concentrate Ratio;
Lactating Crossbred Cows.

Abstract

Residual feed intake (RFI) is defined as actual feed intake minus the expected feed intake of individual animal and it was first proposed as an alternate measure of feed efficiency by (Koch et al 1963). RFI is a heritable character and heritability of RFI as 0.14. selection for traits associated with feed conversion efficiency should lead to greater profitability of dairying. Residual feed intake is a useful selection criterion for greater feed efficiency. The experiment was conducted at Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana . The two roughage: concentrate diets, namely 50:50 (50% roughage: 50% concentrate), 60:40 (60% roughage: 40% concentrate) were made. Twenty four lactating crossbred cows with average milk yield and week of lactation were taken. Twelve cows were divided in to two groups of six animals each and fed ration with 60:40 roughage: concentrate ratio (R_{LC}). The intake of OM and CP were significantly ($p < 0.05$) high in R_{HC} whereas intake of ADF and NDF were significantly ($p < 0.05$) high in R_{LC}. The roughage to concentrate ration has non-significant effect on the intakes of CHO, EE, NE, and ME. The RFI calculated based on DMI were statistical in both the groups. The digestibility of CP and EE were significantly ($p < 0.05$) high in R_{HC} compared to R_{LC} ration but that of ADF was significantly ($p < 0.05$) high in R_{LC} compared to R_{HC} ration. The RFI of R_{HC} had significantly negative ($p < 0.05$) effect on milk protein % but had no effect on milk production, milk energy yield, metabolic body wt., change/kg m.wt, and fat %, fat yield, protein yield and FCM . Nutrient digestibility of R_{HC} is significantly ($p < 0.05$) higher for CP, EE as compared to R_{LC} and that of ADF had significantly ($p < 0.05$) higher in $R_{LC.}$ The milk yield and protein yield of R_{HC} was significantly ($p < 0.05$) higher than R_{LC}. Nutrient digestibility of R_{HC} is significantly ($p < 0.05$) higher for CP, EE as compared to R_{LC} and that of ADF had significantly ($p < 0.05$) higher in $R_{LC.}$ The correlation of RFI with m.b.wt, fat yield, protein yield, FCM was positively significant ($p < 0.05$). RFI with milk yield was significantly ($p < 0.05$) and negatively correlated.

Introduction

The feed costs account for about 80% of total variable costs associated with milk production and utilization of feed with higher efficiency is the basis of profitable dairy farming. There is variation of feed efficiency at the individual level having genetic and metabolic basis for it. There is wide variation of nutrient requirements among individual animals having similar production levels. Measuring gross efficiency of milk production can be erroneous due to fat that dairy animals has substantial body reserves which masks the short term nutrient deficiencies.

An efficient RFI animal will eat less than what is estimated for them, resulting in a negative or lower number. An inefficient RFI animal's calculation will be high because the animal consumes more than what is expected. Selection for DMI amount doesn't necessarily identify an efficient animal because it does not account for the output of the animal.

Corresponding Author: R.S. Grewal, Professor, Department of Animal Nutrition, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab 141004, India.
E-mail-ravigrewal71@yahoo.co.in

Residual feed intake can be calculated by measuring an animal's actual feed intake minus estimated intake [1]. RFI is a method of choice for determining feed efficiency because it takes into the account the production of the animals when determining the estimate of what an animal should eat. By selecting for animal that has a negative RFI value or is efficient, then you are selecting for animals that eat less but gain or produce the same. This would help the producer to get similar output with lower inputs in terms of feed. RFI has been estimated to be moderately heritable character.

Keeping all this in view the present study was undertaken with the objective of estimating residual feed intake in lactating crossbred cows as affected by some animal and dietary factors.

Materials and Methods

Animals and Experimental Design

The experiment was conducted at Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana. The two roughage: concentrate diets, namely 50:50 (50% roughage: 50% concentrate), 60:40 (60% roughage: 40% concentrate) were made.

Twenty four lactating crossbred cows with average milk yield and week of lactation were taken. Twelve cows were divided in to two groups of six animals each and fed ration with 60:40 roughage: concentrate ratio (R_{LC}).

The sample of feed and refusal were taken twice weekly for analysis for proximate principles [2] and cell wall fractions [3]. The body weight of animals was recorded fortnightly. The milk was measured daily and milk composition was estimated at weekly intervals. The blood samples will be taken before start of experiment and at the end of experiment and was analyzed for biochemical constituents like total protein, glucose, BUN, albumin, cholesterol using Micro lab -300 kit (Merck).

Residual feed intake estimation was measured by the method given by [1]. The estimated intakes was calculated from regression of actual intake on energy yielded in milk MJ/d (LE) and the fitted values taken as estimated intakes [4]. The actual ME intake and predicted ME intake were also estimated. The correlations of RFI with various animal and dietary parameters were calculated.

A digestion trial was conducted for 7 days on all experimental cows after 50 days of feeding trial. Collection of fasces was done on 24 hourly basis. Simultaneously daily feed offered and residue left was recorded. The representative samples of feed offered, residue left and fasces voided were collected and analyzed for proximate principles by the methods of [5] in order to determine the digestibility of different nutrients viz. dry matter, crude protein, ether extract, total ash, ADF and NDF.

Result and Discission

The chemical composition of rations is given in Table 2. The rations were iso-nitrogenous. The EE value for treatment R_{HC} was numerically higher than treatment R_{LC}. Variations like these are likely to occur where TMR's are analyzed for nutritional parameters. The DM, OM, NDF, ADF and ASH contents are higher in R_{LC} treatment.

The comparison of nutrient intake of R_{LC} and R_{HC} rations is given in Table 3. The perusal of data showed that the intake of OM and CP were significantly ($p <0.05$) high in R_{HC} whereas intake of ADF and NDF were significantly ($p <0.05$) high in R_{LC}. The roughage to concentrate ration has non-significant effect on the intakes of CHO, EE, NE, and ME. The RFI calculated based on DMI were statistical in both the groups.

Table 1: Ration composition of rations

Ingredient	60:40(R_{LC})	50:50(R_{HC})
Concentrate	7	8.5
Wheat Straw	2	2
Silage	36	28
	(Adjusted on DM basis, fortnightly)	(Adjusted on DM basis, ortnightly)

*R_{LC}=low concentrate ration, R_{HC}=high concentrate ration

Table 2: Chemical composition of rations

Composition, % DM	R_{LC}	R_{HC}
DM	92.55	92.16
OM	91.47	92.10
CP	15.34	15.29
NDF	42.61	37.10
ADF	25.86	24.35
EE	3.06	4.32
Ash	8.53	7.9

The comparison of digestibility of R_{LC} and R_{HC} is given in Table 4. The data showed that digestibility of CP and EE were significantly ($p <0.05$) high in R_{HC} compared to R_{LC} ration but that of ADF was significantly ($p < 0.05$) high in R_{LC} compared to R_{HC} ration. The varying roughage to concentrate ratio had no significant effect on digestibility of DM, OM, NDF, CHO, and TDN in both rations. These results are not in agreement with [6,7,8]who reported decreased apparent digestibility of DM and OM in the total tract as a result of increase in the proportion of roughage in diet from 35 to 65%. The narrow difference between the groups in terms of roughage level in present study might be the reason for similar DM and OM digestibility among the groups. They also reported digestibility of NDF fractions of the diets in treatments that tended to be lower when the roughage proportion was increased in the diet, though the differences was not significant.

The milk yield and protein yield and milk/kg m.wt was significantly ($p < 0.05$) higher in R_{HC} (Table 5). As the animals were of high genetic merit HF crossbred cows, therefore, they responded well to increasing the concentrate in the ration. R_{LC} and R_{HC} had no significant effect on milk energy, fat %, fat yield, protein %, and FCM yield although the FCM was about 13% higher in R_{HC} as compared to R_{LC}. Numerically lower fat% in R_{HC} resulted in non-significant effect on FCM yield among the groups.

The correlation of milk production and composition with RFI is given in Table 6. The data revealed that the correlation of RFI with milk yield was significantly negative where as correlation of RFI with metabolic body weight, fat yield and FCM was significantly positive. The increased milk production tends to lower the RFI of the animal indicating desirable character of efficient milk production.

The RFI of R_{LC} was positively correlated ($p<0.05$) with metabolic body weight, fat yield, protein %, protein yield, FCM and week of lactation (WOL) whereas RFI was negatively correlated with milk yield. Also, RFI of R_{LC} had no significant effect on milk energy yield, change/kg metabolic body weight and fat % .

In this study, the RFI of R_{HC} had significantly negative ($p<0.05$) effect on milk protein % but had no effect on milk production, milk energy yield, metabolic body weight., change/kg m.wt, and fat %, fat yield, protein yield and FCM .

Table 3: Effect of R:C ratio on nutrient intake of animals

Parameter	R_{LC}	R_{HC}	SE	p value
DMI, kg/day	17.47	17.41	0.04	0.17
OMI, kg/day	15.75	15.78	0.01	0.04
CPI, kg/day	2.60	2.68	0.01	0.001
ADFI, kg/day	4.77	4.62	0.04	0.01
NDFI, kg/day	9.30	8.90	0.07	0.001
CHOI, kg/day	12.22	12.07	0.09	0.14
EEI, kg/day	0.64	0.65	0.01	0.11
NEI, Mcal/day	24.01	24.21	0.47	0.39
MEI, Mcal/day	41.11	40.32	1.02	0.30
RFI, kg /day(DM)	-0.80	-2.81	0.01	0.09

Table 4: Effect of R:C ratio on nutrient digestibility of animals

Digestibility coefficient %	R_{LC}	R_{HC}	SE	p valve
DM	63.82	63.20	0.86	0.33
OM	65.38	65.40	0.35	0.96
CP	68.18	71.35	1.10	0.02
EE	79.38	81.26	0.83	0.05
ADF	64.77	63.14	0.58	0.02
NDF	56.54	55.34	1.79	0.32
CHO	62.18	61.83	0.99	0.40
TDN %	63.32	63.81	0.73	0.32

Table 5: Effect of R:C ratio on Milk production and composition

Parameter	R_{LC}	R_{HC}	SE	p valve
Milk yield kg/day	13.41	15.51	0.87	0.04
Milk/kg m. wt	0.31	0.51	0.01	0.001
Milk energy yield, MJ/day	43.33	46.44	1.31	0.07
Fat %	3.83	3.72	0.14	0.34
Fat yield kg/day	0.51	0.57	0.03	0.06
Protein %	3.05	3.00	0.05	0.26
Protein yield kg/day	0.41	0.46	0.03	0.001
FCM kg/day	13.16	14.86	0.93	0.10

Table 6: Correlation of RFI with milk parameters

Parameter	Correlation	p valve
Milk energy yield MJ/day	-0.01	0.97
Metabolic body wt kg/day	0.32	<0.001
Milk energy/kg m.wt	-0.03	0.70
Change/kg m.b.wt	-0.08	0.42
Milk yield kg/day	-0.28	<0.001
Fat %	0.01	0.85
Fat yield kg/day	0.23	<0.001
Protein %	0.10	0.32
Protein yield kg/day	0.30	<0.001
FCM kg/day	0.27	<0.001
Week of lactation (WOL)	0.02	0.83

Conclusion

The intake of OM, ADF, and NDF was significantly ($p<0.05$) higher in R_{LC} whereas CPI was significantly ($p <0.05$) high in R_{HC}. Nutrient digestibility of R_{HC} is significantly ($p <0.05$) higher for CP, EE as compared to R_{LC} and that of ADF had significantly ($p <0.05$) higher in $R_{LC.}$ The milk yield and protein yield of R_{HC} was significantly ($p <0.05$) higher than $R_{LC.}$ The correlation of RFI with metabolic body weight, fat yield, protein yield, FCM was positively significant ($p <0.05$). RFI with milk yield was significantly ($p <0.05$) and negatively correlated.

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Effect of incorporation of coriander seed meal at varying levels on serum biochemical profile in Japanese quail diets

Balachenna Reddy N.[1], Srinivas Kumar D.[2], Raja Kishore K.[3], Naga Raja Kumari K.[4]

[1]Post Graduate Student [2]Professor & Head [3]Assistant Professor, Department of Animal Nutrition [4]Assistant Professor, Department of Poultry Science, NTR College of Veterinary Science, Gannavaram, Andhra Pradesh 521102, India.

Keywords:

Bio- Chemical Profile; Cholesterol; Coriander Seed Meal; Quails.

Abstract

An experiment was conducted to study the effect of coriander seed meal (CSM) at varying levels in the diet of quails on serum biochemical profile. One hundred and fifty day old quail chicks were randomly allotted into 5 experiment groups each with 3 replicates of 10 chicks. CSM was incorporated at 0, 0.5, 1.0, 1.5 and 2.0% levels. All the diets formulated were iso-caloric and iso-nitrogenous. At the end of the experiment, blood was collected from 2 birds/ replicate, thus a total of 30 birds and serum was separated. Results revealed that the total protein, globulin, albumin, calcium and phosphorous contents were increased, ($p<0.01$) whereas serum glucose ($p<0.05$), triglycerides, total cholesterol and creatinine ($P<0.01$) levels were decreased with increase in the level of inclusion of CSM from 0 to 2.0% in the diet. Further, in this study increase ($P<0.01$)in the HDL Cholesterol level and decrease ($p<0.01$) in LDL and VLDL Cholesterol levels were recorded in serum with increased level of inclusion of CSM from 0 to 2.0% in the diet. The present study indicated that coriander seed meal can be incorporated up to 2.0% level as a natural feed additive in the diet of quails for production of low cholesterol meat without any adverse effect on production performance.

Introduction

Quail farming is cropping up as a new venture of diversification of poultry farming due to diverse choices of taste and to strengthen the meat production unit for fulfilling the shortage of animal protein demand. Quail farming is economically viable and technically feasible because quails are quite resistant to various diseases, early sexual maturity (6 weeks of age) and easily adapt to various rearing conditions [1].

In addition, quail meat is a rich source of micronutrients and a wide range of vitamins including the B complex, folate, vitamin E and K. Physical condition and health status of quails can be assessed basing on evaluation of the hematological and serum biochemical profile making them useful tools in differentiating apparently healthy birds from abnormal or diseased ones.

The use of antibiotics as growth promoters has been banned in many countries, due to public concern about their residues in animal products which forced the nutritionist to search for an alternative to antibiotics. Herbs and spices are the most important part of human diet. In addition to boosting flavor, herbs and spices are also known for their potential antimicrobial and stimulating effects on the digestive system. Coriander (*Coriandrum sativum L.*), a well-known aromatic medicinal plant grows in nature and is cultivated in India. Coriander seed has got health supporting reputation. It has anti-diabetic, anti-inflammatory, anti-fungal, anti-parasitic, anti-helminthic, anti-septic, analgesic, sedative and antioxidant properties [2]. Studies conducted earlier indicated that inclusion of coriander seed at 2% level in the broiler diet resulted in decreased glucose, total and LDL cholesterol levels and increased serum total protein, albumin, triglycerides and HDL cholesterol levels [3].

Corresponding Author: Naga Raja Kumari K., Assistant Professor, Department of Poultry Science, NTR College of Veterinary Science, Gannavaram, Andhra Pradesh 521102, India.

E-mail: nkkallam3@gmail.com.

Keeping in view of demand from the consumer for lean meat and available literature is scanty on hypo-cholesterolemic effect [4] of coriander seeds, the present investigation was conducted to study the effect of incorporation of coriander seed meal at varying levels in diet on serum biochemical profile in Japanese quails.

Materials and Methods

One hundred and fifty day old quail chicks were procured and randomly allotted into 5 groups each with 3 replicates of 10 chicks. Chicks were wing banded and weight of the chick was recorded. The experiment was carried out for 5 weeks in a completely randomized design (CRD). During the experiment, coriander seed was ground and was included at 0% (Control, T_1), 0.5% (T_2), 1.0% (T_3), 1.5% (T_4) and 2.0% (T_5) levels in diets. All the diets were iso-caloric and iso-nitrogenous. The quail diets were formulated as [5] specified. All the chicks were housed in battery brooders under uniform management conditions. Feed and water were provided *ad libitum*.

At the end of the trial (5th week), two birds per replicate and thus a total 6 birds per treatment were randomly selected, weighed and slaughtered. Blood was collected from each bird (total of 30 birds) and serum was separated. Serum biochemical parameters like total protein, albumin, globulin, glucose, triglycerides and total cholesterol, various other forms of cholesterol, creatinine, calcium and phosphorus were estimated by using diagnostic kits (M/s. Span Diagnostics Private Limited). All the feed samples were analyzed for proximate principles [6].

Statistical Analysis

Statistical analysis of the data was carried out according to the procedures suggested [7].

Results and Discussion

The ingredient and chemical composition of diets formulated by incorporating coriander seed meal at varying levels and fed to Japanese quails in the present study was shown in Table 1. The diets were iso-nitrogenous and iso-caloric with a protein energy ratio of 1:121, by using ingredients like maize, DORB, soybean meal, fish meal and coriander seed meal as per [5] specifications. The effect of inclusion of coriander seed at varying levels in the diet on serum biochemical profile of quails was shown in Table 2 & 3.

Table 1: Ingredient (%) and Chemical composition (% DM basis) of quail diets

Constituent/ Diet	T_1 Control	T_2	T_3	T_4	T_5
Maize	49.80	49.5	49.40	49.20	49.00
De oiled rice bran	8.30	8.10	7.70	7.40	7.10
Soybean meal	34.50	34.50	34.50	34.50	34.50
Fish meal	5.00	5.00	5.00	5.00	5.00
Coriander seed	0.00	0.50	1.00	1.50	2.00
Di calcium phosphate	0.30	0.30	0.30	0.30	0.30
Shell grit	1.20	1.20	1.20	1.20	1.20
Salt	0.25	0.25	0.25	0.25	0.25
Trace min mix	0.15	0.15	0.15	0.15	0.15
Feed additives	0.50	0.50	0.50	0.50	0.50
Total	100	100	100	100	100
ME* (kcal/kg)	2900.33	2900.58	2903.13	2904.53	2905.93
Crude protein# (%)	24.03	24.05	24.04	24.04	24.05

*Calculated value # analyzed value

Table 2: Effect of dietary incorporation of CSM at varying levels on total serum protein, albumin and globulins (g/dl)

Treatment	Total protein	Albumin	Globulin
T_1	$3.80^a \pm 0.01$	$2.36^a \pm 0.01$	$1.44^a \pm 0.01$
T_2	$3.86^b \pm 0.01$	$2.40^a \pm 0.02$	$1.46^a \pm 0.02$
T_3	$3.93^c \pm 0.16$	$2.45^b \pm 0.01$	$1.48^a \pm 0.01$
T_4	$4.05^d \pm 0.01$	$2.51^c \pm 0.01$	$1.54^b \pm 0.01$
T_5	$4.10^e \pm 0.01$	$2.54^c \pm 0.13$	$1.56^b \pm 0.01$
SEM	0.02	0.01	0.01
SS	**	**	**

Values in column bearing different super scripts differ significantly ** ($p<0.01$).

Table 3: Effect of dietary incorporation of CSM on serum biochemical profile (mg/dl)

Treatment	Glucose	Triglycerides	Total cholesterol	HDL-C	LDL-C	VLDL-C	Creatinine	Calcium	Phosphorous
T_1	$235.56^{b} \pm 0.22$	$143.35^{c} \pm 0.01$	$210.61^{d} \pm 0.01$	$131.62^{a} \pm 0.01$	$50.32^{c} \pm 0.01$	$28.69^{c} \pm 0.01$	$1.30^{c} \pm 0.01$	$18.44^{a} \pm 0.01$	$8.36^{a} \pm 0.01$
T_2	$233.07^{b} \pm 2.22$	$138.04^{b} \pm 0.01$	$208.54^{c} \pm 1.00$	$133.21^{a} \pm 0.92$	$47.72^{c} \pm 1.90$	$27.60^{b} \pm 0.01$	$1.27^{bc} \pm 0.01$	$18.71^{b} \pm 0.01$	$8.48^{a} \pm 0.01$
T_3	$225.66^{ab} \pm 7.41$	$136.34^{b} \pm 1.27$	$204.69^{b} \pm 0.94$	$135.16^{b} \pm 1.04$	$42.26^{b} \pm 1.66$	$27.27^{b} \pm 0.25$	$1.26^{b} \pm 0.01$	$19.35^{c} \pm 0.01$	$8.51^{a} \pm 0.01$
T_4	$221.51^{a} \pm 0.12$	$133.01^{a} \pm 1.44$	$202.17^{a} \pm 0.01$	$137.26^{c} \pm 0.01$	$38.30^{a} \pm 0.29$	$26.60^{a} \pm 0.29$	$1.24^{ab} \pm 0.01$	$19.93^{d} \pm 0.01$	$8.75^{b} \pm 0.10^{b}$
T_5	$219.80^{a} \pm 0.09$	$131.16^{a} \pm 0.01$	$201.97^{a} \pm 0.01$	$138.25^{c} \pm 0.01$	$37.48^{a} \pm 0.01$	$26.23^{a} \pm 0.01$	$1.22^{a} \pm 0.01$	$20.09^{e} \pm 0.05$	$8.76^{b} \pm 0.08$
SEM	1.84	0.86	0.69	0.52	1.05	0.17	0.01	0.12	0.04
SS	*	**	**	**	**	**	**	**	**

Values in column bearing different super scripts differ significantly ** ($p<0.01$), *($p<0.05$).

Serum Total Protein

The serum total protein content (g/dl) increased significantly ($p<0.01$) with increased level of coriander seed meal in the diet of quails (Table 2). These results corroborated with the findings [3], who reported significantly ($p<0.05$) higher total serum protein values upon feeding 2.0% coriander seed meal in broiler diet under high ambient temperatures. Similarly, increased total serum protein concentration upon feeding diets containing coriander seed in broiler chickens were also reported earlier [8,9,10].

Serum Albumin

A significant increase ($p<0.01$) in serum albumin content (g/dl) was observed with increased level of incorporation of coriander seed meal from 0 to 2.0% in the diet of quails (Table 2). Corroborating the results of the present study, [3] reported significantly ($p<0.05$) higher serum albumin content in broilers fed coriander seed at 2.0% level in the diet under high ambient temperatures. Similarly, [11] reported increased plasma albumin levels in broiler chicken upon feeding basal diet with 0.1 and 0.2% levels of summer shield supplementation, which contained 10% coriander extract along with other herbs. On other hand, [9] reported that feeding diets containing different levels of coriander seeds (0.2, 0.4 and 0.6% levels) had no effect ($p>0.05$) on serum albumin content in broiler chicken as compared to the control.

Serum Globulin

The serum globulin content (g/dl) increased significantly ($p<0.01$) with increased level of incorporation of coriander seed meal in the diet of quails (Table 2). This might be attributed to the improved immune system. The results of the present study are in agreement with those of [11] who reported increased plasma globulin levels in broiler chicken upon feeding basal diet with 0.1 and 0.2% levels of summer shield supplementation, which contained 10.0% coriander extract along with other herbs. On other hand, [9] observed feeding coriander seed had no effect ($p>0.05$) on serum globulin content in broiler chicken. In contradiction, [3] reported lower ($p<0.05$) serum globulin levels in broiler chicken when fed 2.0% coriander seed in the diet as compared to the control .

It is reported that coriander has anti-microbial effects [12], anti-fungal effects [13] and contain anti-oxidants that decrease lipid oxidation [14] which might have enhanced the immune system resulting in increased concentration of serum parameters related to immunity *viz.* total protein, albumin and globulin levels.

Serum Glucose

The serum glucose content (mg/dl) decreased significantly ($p<0.05$) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 3). These results are in agreement with the findings of [3] in broiler chicks under high ambient temperatures, by incorporation of CSM upto 2%. The reduction in serum glucose content observed upon coriander seed inclusion in the diet may be attributed to the insulin releasing and insulin like activity of coriander seed [15].

In line with the findings of present study [8,16,10,11] reported decreased serum glucose content in broiler chickens, in contrast to this [17] reported, incorporation of coriander seed in broiler diets had no effect (p>0.05) on serum glucose concentration.

Serum Triglycerides

The serum triglyceride content (mg/dl) decreased significantly (P<0.01) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 3). [18] reported that supplementation of coriander oil at 2.0 % in the diet had resulted in significant decrease (p<0.05) in serum triglyceride content of broilers. Similarly, decreased serum triglyceride content in broiler chicken upon feeding coriander seed in the diet was reported earlier [8,9,10,11,19]. The decreased serum triglyceride content observed in quails upon feeding coriander seed in the diet might be attributed to its hypo-lipidaemic effect [4].

In contradiction to this results, [3] reported higher (p<0.05) serum triglyceride content in broilers fed coriander seed at 2.0 and 3.0% in the diet under high ambient temperature compared to control and 1.0% groups. However, [17] reported that feeding coriander seed in the diet had no effect (p>0.05) on serum triglyceride content in broiler chicken.

Serum Total Cholesterol

The serum total cholesterol content (mg/dl) decreased significantly (p<0.01) with increased level of incorporation of coriander seed from 0 to 2.0% in the diet of quails (Table 3). Whereas, [3] Reported lower (p<0.05) serum cholesterol in broilers fed coriander seed at 2.0 and 3.0% level under high ambient temperature. The decrease in the serum cholesterol levels observed in the present study could be attributed to the incorporation of coriander seed in the diet might reduced the activity of 3- enzyme-3-methylglutaryl CoA (HMG-CoA) in the liver which is the key regulatory enzyme in cholesterol synthesis [20]. Whereas, observed 2% lowering of serum cholesterol in poultry by inhibiting 5% of HMG-CoA reductase. Further, coriander seeds increases the concentration of hepatic and fecal bile acids and neutral sterols which resulted in increasing hepatic degradation of cholesterol [20].

Corroborating the results of the present study, several researchers reported that inclusion of coriander seed resulted in decreased serum total cholesterol content [9,11,17] in broiler chicken.

Serum HDL Cholesterol

The serum HDL cholesterol content (mg/dl) increased significantly (p<0.01) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 3). Whereas, [3] also reported that feeding coriander seed in the diet resulted in increased (p<0.05) serum HDL cholesterol concentration in broiler chicks reared under high ambient temperature. The increased serum HDL content observed in quails upon feeding coriander seed in the diet might be due to the significant hypo-lipidaemic effect resulting in lowering the total cholesterol levels and triglycerides and thus increasing the levels of high density lipoprotein [4].

Similarly, [11] observed increased serum HDL cholesterol levels in broiler fed diets supplemented with summer shield at 0.1 and 0.2% level which contained 10% coriander extract along with other herbs. However, [17,18] reported that feeding of coriander seed in the diet had no effect (p>0.05) on serum HDL cholesterol content in broiler chicken.

Serum LDL Cholesterol

The serum LDL cholesterol content (mg/dl) decreased significantly (p<0.01) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 3). However, [3] reported significantly (p<0.05) lower serum LDL cholesterol in broiler chicken fed coriander seed at 2.0% level in the diet under high ambient temperature. The decreased serum LDL content observed in quails upon feeding coriander seed in the diet might be attributed to enhanced hepatic bile acid synthesis and to increased degradation of cholesterol to fecal bile acids and neutral sterols [20]. Similarly, [11,18] reported significantly (p<0.05) reduced serum LDL cholesterol while [17] reported no effect (p>0.05) on serum LDL cholesterol content in broiler chicken upon feeding coriander in the diet.

Serum VLDL Cholesterol

The serum VLDL cholesterol content (mg/dl) decreased significantly (p<0.01) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 3). This might be attributed to the hypo-lipidaemic effects of coriander seeds that enhanced hepatic bile acid synthesis and increased the degradation of cholesterol to faecal bile acids and neutral sterols [20].

Serum Creatinine

The serum creatinine content decreased significantly (p<0.01) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 3). Whereas [9] reported that creatinine levels showed a significant (p<0.01) decrease in broilers receiving 0.2, 0.4 and 0.6% coriander seed in the diet as compared to the control. Significant increase in serum uric acid and creatinine levels are indicative of nephrotoxicity in broiler chickens [21]. Thus, the decreased (p<0.01) serum creatinine content observed in the present study indicate the improved kidney health in terms of filtration rate which may be attributed to the incorporation of coriander seed in the diet.

Serum Calcium and Phosphorous

The serum calcium and phosphorous contents increased significantly (p<0.01) with increased level of coriander seed from 0 to 2.0% in the diet of quails (Table 3). The increased serum calcium and phosphorous level observed in the present study may be attributed to the higher levels of calcium and phosphorus present in coriander seed meal. Similarly, several authors reported that feeding herbs and spices *viz*. fenugreek [22], cinnamon [23], and black pepper [24] in the diets resulted in increased serum calcium and phosphorous content in quails.

Conclusion

The present study indicated that incorporation of coriander seed meal up to 2.0% level in the diet had improved the good cholesterol content (HDL-C) and reduced the total, LDL and VLDL cholesterol and triglyceride content in quails. Thus, it is concluded that coriander seed can be incorporated up to 2.0% level in the diet of quails without any adverse effect.

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Sub-therapeutic use of antibiotics in animal feed and their potential impact on environmental and human health: a comprehensive review

Atul Kumar[1], Anil Patyal[2], A.K. Panda[3]

[1] Assistant Professor [3]Professor and Head, Department of Veterinary Public Health and Epidemiology, Dr. G. C. Negi College of Veterinary and Animal Sciences, CSK Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh 176062, India.
[2]Assistant Professor, Department of Veterinary Public Health and Epidemiology, College of Veterinary Science and Animal Husbandry, Chhattisgarh Kamdhenu University, Anjora, Durg, Chhattisgarh 491001, India.

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Abstract

The increasing human population and rising incomes across the globe proportionally increases the demand for food and other livelihood resources. The requirements for wholesome and nutritious food are ever-increasing and animal husbandry sector has contributed much to the needs of people. Several measures have been applied to increase the productivity of livestock which has resulted in significant increase in the milk, meat, eggs and fish production. However, animal products can potentially be contaminated with thousands of chemicals used for various purposes in routine animal husbandry practices. Among veterinary drugs, antibiotics are the most widely used ones for chemotherapeutic and prophylactic purposes as well as feed additives to promote growth and improve feed efficiency in livestock. Although, the safe and effective use of antibiotics in animals has received considerable attention in most of the countries around the globe including India. However, the indiscriminate use of antimicrobials in animal husbandry practices especially sub-therapeutic usage in animal feed as a growth promoter may have plethora of adverse impacts on human and environmental health. Therefore, the present review is an effort to address the various issues pertaining to sub-therapeutic usage of antibiotics in animal feed, methods for their detection in foods of animal origin and their potential risks to human and environmental health.

Introduction

Antibiotics are used in livestock production system to maintain health and productivity of animals. For more than four decades, Indian livestock and poultry producers have used antibiotics in animal husbandry practices and therefore; issues on safety to animals and humans and continued efficacy of antibiotics have been raised throughout the history of their usage. Usually, these drugs are administered in relatively large (therapeutic) doses to treat sick animals. However, sub-therapeutic doses of antimicrobial are also being frequently used in animal feeds to improve feed efficiency and rate of growth and to prevent or reduce the incidence of infectious diseases such as necrotic enteritis in chickens, dysentery and proliferative enteropathy in porcine etc. [1]. Generally, in management of livestock including poultry, antibiotic usage has expanded to an extent that approximately 70-80% of all animals reared for food purposes receive medication for at least once in their lives.

Antibiotics play a very crucial role in animal production for number of reasons. However, owing to their increased and non-judicious use in animal nutrition and clinical medicine; great attention from consumer's health point of view has centered on the safety of their residues in food of animal origin i.e. milk, meat, eggs, fish and even honey [2]. The contamination of otherwise usable milk, meat and eggs by residues of antibiotics and their subsequent widespread release into the environment is a frequent sequel to antibiotic usage in food producing animals [3]. Antibiotic residues in food of animal origin are also a priority for the industry because higher

Corresponding Author: Atul Kumar, Assistant Professor, Department of Veterinary Public Health and Epidemiology, Dr. G. C. Negi College of Veterinary and Animal Sciences, CSK Himachal Pradesh Agricultural University, Palampur, Himachal Pradesh 176062
E-mail: dratul9@gmail.com

standards of food safety assurance are being required by our society. Further, presence of residues in such animal origin food products may also prove as a barrier for export of these products due to strict food hygienic standards and residue limits established by the international community.

The indiscriminate use of antibiotics and their subsequent presence in animal origin food not only affects the industry but also poses a serious threat to human and environmental health including the emergence of antibiotic resistant microorganisms, carcinogenic and mutagenic effects, possible allergic/ hypersensitivity reactions in certain individuals and ecological disturbances. The Food and Drug Administration (FDA) considers antibiotic contaminated food as adulterated. In order to safeguard human health, the World Health Organization (WHO), Food and Agriculture Organization (FAO) together with OIE (World Organization for Animal Health) has consistently recommended restrictions on non-therapeutic uses of antibiotics in animal agriculture [4]. WHO and FAO has also set standards for acceptable daily intake (ADI) and maximum residue limits (MRLs) in animal origin food products. Discarding contaminated animal products represents a considerable economic loss in itself. However, failure to discard such food items may lead to severe penalties if antibiotics are detected in the supply submitted for sale.

Hence, there are various areas of concern over the usage of antibiotics and the threat to the human and environmental health. Therefore, the present review discusses this aspect of sub-therapeutic usage of antibiotics in animal feeds, methods of their detection in animal food products along with their impacts on human and environmental health with the objectives to create interest in pursuing answers for some of the complex issues relative to this subject.

Sub-Therapeutic Use of Antibiotics in Animals

Antibiotics are therapeutically used in food-producing animals to treat existing infections and prophylactically to prevent development or control spread of disease and, to increase daily body weight gain or the amount of growth per unit of feed eaten (i.e., feed efficiency) by administering doses lower than those required to treat or prevent disease, over extended periods of time [5]. Almost all food-producing animals are raised in groups and administering drug individually to all the animals is not only stressful to animals and handlers but is also expensive and dangerous as it contributes to spread of diseases too. Therefore, practically, addition of antibiotics to animal feed (or water) is the most common way to administer drugs to groups of animals especially in large commercial farms. Moreover, it is generally appreciated that the use of sub-therapeutic doses of antibiotics is one of the best available tool which has facilitated intensive animal farming. This practice has contributed to lowering production costs per animal, which has ultimately led to a greater availability and lower costs of animal origin foods (meat, milk and eggs) to the consumers, leading to overall improvement of animal and human health [6].

The growth promoting effects of antibiotics were first discovered in 1940s when a few farmers in USA found that pigs fed with penicillin-fermented mixture grew faster [7-9] and chickens fed by-products of tetracycline fermentation were found to grow faster than those that were not fed those by-products [10]. Since then, antibiotics are commonly added to commercial feed for improving growth especially in poultry and piggery. Numerous studies have witnessed the applicability and beneficial effects of antimicrobials in improving promoting growth, feed efficiency, reproductive performances and overall carcass quality of animals as summarized in Table 1.

Often, the amount of antibiotics given is not under the direct control of the farmers, due to premixed antibiotics contained in the feed they purchase. However, there is scarcity of data on antibiotics usage in animal husbandry practices, which could be attributed to lack of surveillance systems, unwillingness of food animal producers, animal feed producers, and veterinary pharmaceutical companies to provide comprehensive reports of antimicrobial consumption or sales [28]. But, growing demand for animal protein globally has undoubtedly expanded the usage of antibiotics in animal husbandry practices.

No published estimates of antimicrobial use in animals exist at present, and estimates of that use differ markedly. National Research Council of USA estimated that 40% of the antibiotics produced are used for feed additives with estimated allocation of 0.5 million kg to the cattle industry, 1.0 million kg to poultry, 1.4 million kg to swine, and 0.4 million kg to other animals such as companion animals [29]. More than 40% of the drugs were added in animal feed at sub-therapeutic level for improving animal production in USA during 1990s [18]. With a substantial contribution to the development of food-animal production at global level, veterinary antibiotics tend to be necessities to cope with increasing food demand for humans. In 2013, the global consumption of all antimicrobials in food animals was estimated to be 100, 812 -190, 492 tons and if the same trend is followed it is projected to

Table 1: Effect of antimicrobials on feed efficiency, growth promotion, reproductive performance, and carcass quality –Evidences

Compounds	Species	Observations	Reference
Tiamulin, Nosiheptide Salinomycin	Pigs	Improvement in carcass quality	[11-14]
Chlortetracycline	Sows	Increased conception and farrowing rates	[15]
Salinomycin	Weaning Piglets	Increased average weight gain	[16]
Antimicrobials	Pigs	Increased digestion of nitrogen and phosphorus	[17,18]
Antimicrobials	Pigs	Increased feed utilization and weight gain	[18]
Avoparcin, Bacitracin Efrotomycin, Lincomycin, Penicillin G procaine Virginiamycin	Poultry	Improvement in weight gain and feed efficiency	[19]
Roxarsone Bacitracin Virginiamycin	Poultry	Improved growth and feed conversion efficiency	[20]
Salinomycin, Avilamycin,	Poultry	Improved growth	[21]
Bacitracin	Poultry	Increased feed intake and decreased feed conversion ratio	[22]
Bacitracin zinc, Colistin sulfate, Flavomycin, Florfenicol	Fish	Improvement in feed conversion and growth	[23,24]
Tetracycline, Penicillin	Poultry	Improvement in egg production, hatchability and feed efficiency	[25]
Antibiotics in feed	-	Better quality meat with higher amount of protein and less fat	[26]
Avilamycin	Poultry	Increased weight gain	[27]

reach 150,848-297,034 tons by 2030. Further, India has been ranked as the fourth largest user of antibiotics in animal feed which is expected to increase by 82% in India by 2030 [30]. In a similar study conducted in some northern Indian states by Centre for Science and Environment, New Delhi (India) observed that that the extensive use of antibiotic supplements in the animal feed, and untreated litter has given rise to the growth of drug resistant bacteria and they are spreading out of the farms because of poor hygiene practices and improper waste management [31].

Human and Evironmental Health Risks

Human Health Risks

It is undeniable that rational use of antimicrobials plays a vital role in the production of food animals and protecting public health, while irrational and irresponsible use may cause various health problems in humans [32]. The potential effects of using antibiotics in domesticated animals have caused serious public health concern for decades. Early concerns focused mainly on the use of antibiotics in animal feed for growth promotion. In 1960, government of the United Kingdom of Great Britain and Northern Ireland (UK) established the Netherhorpe Committee to investigate whether use of antibiotics in animal feeds constituted a danger to humans. This was followed, in 1968, by the UK government-appointed Swann Committee (Joint Committee on the Use of Antibiotics in Animal Husbandry and Veterinary Medicine) which concluded that administration of antibiotics to food-producing animals poses significant hazards to human and animal health because it leads to the emergence of antibiotic resistant strains of bacteria [33].

However, establishing direct causal associations between usages of antibiotics in animal husbandry practices and their potential risks to human health is often difficult. But, several studies have measured antibiotic residues in animals or animal products as a proxy for the level of antibiotic usage in animal production and management [34]. Among the different classes of antibiotics, tetracyclines and fluoroquinolone residues have been most frequently reported in animal origin food products [35-37].

Further, studies have shown a close association between the prevalence of antibiotic resistant bacteria in animals and in humans [38-40]. Numerous ecological, cross-sectional and evidence based studies has attempted to establish the link between prevalence of antimicrobial resistance bacteria and use of antibiotics in food animal production especially in contexts of cattle, pigs, and poultry. For example, in an ecological study of temporal trends in Netherland, it was observed that the introduction of vancomycin and pristinamycin in swine production was associated with increased prevalence of resistant *Enterococci* from human fecal samples [41]. Similarly, in a cross-sectional study in US, correlations among quinupristin-dalfopristin resistance in *E. faecium* isolates have been drawn between humans, farm animals, and meats [42].

Now, it is well established that all antimicrobial drugs have side effects when human and animals are exposed to them with higher doses or for prolonged period of time than recommended. The loss of effectiveness of the most widely used antibacterials (i.e., tetracyclines and penicillin) and of other antibacterials with plasmid-mediated resistances poses risks to both human and animal health. Therapeutic failure with these antibacterials would lead to large but unquantifiable morbidity and mortality in humans and animals. Therefore, the health risks from the development of bacterial resistance to antibacterial in animal feeds is cause for great concern. Currently, some unbiased, scientific data demonstrate that usage of antibiotics in food-producing animals (cattle, swine, poultry, and fish), particularly large-scale administration (e.g., in feed) of low doses over long periods of time, poses following public health threat:

Development of antimicrobial resistance (AMR) and other human health hazards

Antimicrobial resistance (AMR) is resistance of a microorganism to an antimicrobial drug that was originally effective for treatment of infections caused by it. It is a major public health crisis, threatening the emergence and reemergence of untreatable infectious diseases worldwide on a massive scale [43-45]. Understanding the process of evolution and spread of antimicrobial resistance is of utmost importance to evaluate the contribution of animal husbandry practices in development of this grave public health issue. From fundamental biology and evolutionary perspective, the development of antimicrobial resistance in response to exposure to antibiotics is inevitable [46]. Bacterial exposure to sub-lethal concentrations of antimicrobial agents drives the selection of resistant strains. If such exposure is continued for considerable period of time then resistant strains are advantaged in terms of reproduction and spread. The other important scientific principles behind development of AMR includes genetic and regulatory changes in bacteria developing resistance to antibiotics, transfer of resistance genes from one bacterium to another and finally, the resistance may continue even after antimicrobials are no longer present as suggested by some of the findings of research works conducted by various researchers [47,48].

As per WHO, emergence of antibiotic resistant microorganism is one of the most serious global medical problems particularly in developing nations, including India, where the burden of infectious diseases is high and healthcare spending is low. The country has among the highest bacterial disease burden in the world. Antibiotics, therefore, have a critical role in limiting morbidity and mortality in the country. Medical authorities are already confronted with infections for which no antibiotic is effective because the causative bacteria have acquired resistance to all available antibiotic agents. AMR, the global spread of drug resistant bacteria, is currently responsible for approx. 0.7 million annual deaths worldwide and if the status quo is maintained then AMR could evolve into a global calamity, killing some 10 million people annually by 2050 [49]. AMR is also a threat to the livestock sector and thus to the livelihoods of millions who raise animals for subsistence [50].

One of the issues receiving close attention at the moment is the link between use of antibiotics in animals and the development of resistance in human pathogens. Antimicrobial resistant bacteria of animal origin can be transmitted to humans through the contaminated environment and food products and by direct contact with animal handlers [51-53]. There is evidence that resistance in some human enteric pathogens has arisen because of transfer of resistant bacteria or resistance genes from animals to people via the food chain [54]. Over-use and misuse of antibiotics therapeutically has driven the resistance problem in human medicine whereas it would seem that prophylactic use to some extent and growth promotant use in particular have contributed most to the emergence of resistant bacteria in animals [41]. Some of the resistance problem can be attributed to the transfer of resistant bacteria from animals to human and the transfer of resistance genes from animal pathogens and commensal bacteria to human pathogens [55]. However, for purposes of truly understanding attributable risk, it is important to determine the antibiotic residues in animal feed, milk, meat, eggs, fish, water etc. along with acquisition of information on origin of resistant infections.

Apart from development of AMR, the presence of antibiotics or their residues in food of animal origin is also associated with several other adverse human health effects. Several antibiotics are potent antigens or act as a haptens and their occupational exposure on a daily basis can lead to hypersensitivity reactions. The most of the hypersensitivity reactions have been reported against ß-lactam antibiotic residues in milk or meat. Such reactions can lead to urticaria, anaphylaxis, bronchospasm, angioedema, hemolytic anemia, thrombocytopenia, acute interstitial nephritis, serum sickness, vasculitis, erythema multiforme, Stevens-Johnson syndrome and toxic epidermal necrolysis etc. [56]. The nitrofurans at higher concentrations in milk may cause carcinogenic and mutagenic effects [57]. Etminan et al. [58] reported the risk of retinal detachment in individuals upon continued exposure to fluoroquinolones. Chloramphenicol is also associated with optic neuropathy, aplastic anemia and brain abscess with varied intensities and clinical manifestations [59-62].

Environmental Risks

With the developments in analytical techniques, it has now become evident that man-made antibiotics can make their way to the environment through various routes namely, direct discharges from manufacturing units, excretion through biological matter (urine and faeces) of animals and humans after usage or through discarding unused medicines [63,64]. Such exposure routes may eventually leads to accumulation of antibiotics in the environment which may have profound effects on some ecosystems.

Effect on micro-ecosystem

One of the concerns is the potential effect of antibiotics on the ecological climax. Soil micro-organisms play a very important role in maintaining the balance in ecosystem e.g. nitrogen fixation, and antibiotics has potential to disrupt such processes. However, we still lack sufficient evidences for establishing links between antibiotic exposure and disturbed ecosystem. Likewise, waste-water treatment plants for household and industrial discharges largely depends on the functionality of complex microbial ecosystems, which could be disturbed by antibiotic exposure. However, many microbial ecosystems tend to show a large degree of resilience owing to their ability for horizontal gene transfer. Thus, even after long duration of exposures to high concentrations of antibiotics, environmental compartments appear to harbor a very diverse microbial flora. Although, the critical point is, of course, the exposure level required to affect the function of the microbial ecosystems e.g. the waste water treatment plants, receiving highly contaminated waste from pharmaceutical units manufacturing antibiotics may witness a disturbed function [65].

Effect on biogas production

A large amount of antibiotics used for intensive animal farming are excreted out in the environment through animal excreta and waste water. Those antibiotic residues in the environment may partially inhibit methanogenesis in anaerobic waste-storage facilities, commonly used at Concentrated Animal Feeding Operation (CAFOs), and thus, decrease the rate at which bacteria metabolize animal waste products [63,66]. During the anaerobic digestion of livestock waste, certain antimicrobials, including amoxicillin, aureomycin, oxytetracycline, thiamphenicol, florfenicol, sulfadimethoxine, and tylosin, had inhibitory effects on methane production [67-70]. However, in few studies, it was observed that the amount of antibiotics required for inhibiting anaerobic digestion of pig waste slurry was very high. Amin et al. [70] reported that concentrations of oxytetracycline, amoxicillin, andtylosin required for producing inhibitory effects are 8000, 9000, and 9000 mg/L, respectively. Similarly, only high concentration of thiamphenicol (160 mg/L), amoxicillin (120 mg/L), tetracycline (50 mg/L), and sulfamethoxydiazine (50 mg/L) had inhibitory effect on biogas production in the anaerobic digestion of pig waste slurry [67,69]. In reality, it is very difficult to observe such high levels of antibiotics in the excreta.

Determination of Antibiotic Residues in Foods of Animal Origin

Determination of antibiotic residues has become essential and growing concern in recent years for maintaining healthful characteristics of food stuffs and protecting public health. Moreover, the successful implementation of national regulations and monitoring/surveillance programmes depends upon availability and use of appropriate analytical techniques. Numerous techniques are available, employed and are in practice like enzyme linked immunosorbent assay (ELISA), bioassays for screening and high performance liquid chromatography (HPLC) coupled with photodiode array/UV/Fluorescence detectors/Mass spectrometry to identify and quantify the commercially used antimicrobial agents in feed and their residues in food of animal origin [2, 71].

Biosensors provide several advantages such as opportunity for automation, *in situ* analysis and development of large number of commercial detection kits. Further, they are highly specific, quick and can also detect non- polar molecules in real time [72]. But the limitations include chances of their contamination and failure to get heat sterilized [73].

ELISA is a widely used method for the detection of antibiotic residue in all kinds of food samples [74]. ELISA based techniques have the advantage of high sensitivity, broad specificity and ability to handle large number of small volume samples in short time [75]. But expensive nature and failure to detect the residues in real time are its major drawbacks [76].

HPLC coupled with selective detectors like Diode array detector (HPLC-DAD), Fluorescent detector (HPLC-FLD) or Mass Spectrometry (HPLC-MS) is another effective and sensitive system for the detection of antibiotic residue. HPLC coupled with tandem mass spectrometry techniques (HPLC-MS/MS) has been recommended by the Food safety and standard authority of India (FSSAI) for determination and quantification of most of the antibiotic residues in foods of animal origin. However, owing to its expensive nature very few laboratories in India have this facility to routinely test the food samples. Every method has its own limitations, with some lacking sensitivity and/or specificity, others are time consuming and quite expensive to execute in routine analysis.

Perplexity and Dilemma

Although a definitive link between antibiotic usage in animal feeds and their potential risks to human health is clear, but a number of data gaps still remains. For instance, antibiotic residues are also released into the environment through human waste and disposal and particularly around the sites of antibiotic production, and have been detected in ground and surface waters and soil [77,78]. In India, some of the highest levels of residues ever detected in surface waters were found in lakes and wells surrounding a wastewater processing plant that serves close to 100 pharmaceutical manufacturing plants around Hyderabad [79]. Therefore, occurrence of antibiotic residues in environmental compartments can also contribute to emergence of resistance strains. The proponents of sub-therapeutic antibiotic usage in animal feed believe and argue that such small doses of antibiotics used for this purpose are very small as compared to their therapeutic doses and it is not definitely known whether such low doses really select for resistance or not [80]. Even those, who accept that use of antibiotics as growth promoters in animal feeds may promotes emergence of antibiotic-resistant strains, believe that evidence of this possibility having a major impact on human health is either non-existent or minimal [81]. Moreover, the fact that various bacterial species showing resistant to antibiotics used in animals does not prove their origin and it is contended that humans might contract the infection from some other source and there is possibility that both animals and humans are infected with the same resistant organism from a common source. This is supported by the fact that drug resistant isolates from humans and animals were found to be genetically different in many instances [82].

The provisional supposition on transmission of resistance through food chains is also not universally accepted. Those, who accept it, recommend good hygienic practices in the kitchen and use of vaccines in the birds and animals to reduce the incidence of transmission. Therefore, the proponents believe that a ban on the sub-therapeutic use of antibiotics may lead to an overall deterioration of animal health (in terms of diarrhea, weight loss, reproductive failures and mortality). Hence, this may further lead to increased incidences of food-borne infections and intoxications in consumers; subsequently leading to more frequent use of antibiotics for therapeutic purposes in animals [83,84]. Therefore, restriction on the use of antibiotics as feed additive is considered unwarranted by some of the proponents.

However, in today's scenario, this does not justifies the inappropriate or sub-therapeutic use of antibiotics in animal agriculture. Some earlier economic analyses suggested that there is meager economic benefit from using antibiotics as feed additives, and that equivalent improvements in growth rate and feed consumption can also be achieved by improved hygiene [55]. A recent report indicated that the costs of withdrawing antimicrobial growth promoters in India would be roughly US$1.1 billion. However, widespread resistance may hold more consequence for India than for other countries because of India's high bacterial disease burden [85].

Further, Sub-therapeutic use of antibiotics in animal feeds has been questioned since the introduction of antibiotics because the infectious agents can develop resistance to the antibiotic being used and perhaps to other antibiotics as well. Emergence of antibiotic resistant pathogens appeared soon after antibiotic usage began and such resistance is known to be capable of compromising antibiotic therapy. Although, the potential human health hazards due to development of bacterial resistance to antibiotics used at sub-therapeutic levels in animal feeds is clear enough; but, only very few recorded instances of unfavorable human health effects due to antibiotic resistant bacteria have been linked directly to all usages of antibiotics in the production of many billions of animals over the past many decades [86]. It is very difficult to conduct a feasible, comprehensive epidemiological study of the effects on human health arising from the sub-therapeutic use of antibiotics in animal feeds. This is because, it is not easy to determine the antimicrobial history of the animal from which a particular piece of meat or glass of milk came, especially in large developing countries like India with 120 billion human population. Moreover, it is also very difficult to determine the antibiotic history of the humans with respect to their direct/indirect exposure to antibiotics or to organisms from other people who had been exposed directly to sub therapeutic doses of antibiotics.

Further, there are apprehensions among researchers that the economic consequences of limiting sub-therapeutic usage of antibiotics in animal feed could be significant over the short term, but most of the drugs in question could be replaced with alternative drugs already approved by FDA. Thus, the balance between immediate economic benefits and future health risks is very important. However, the lack of scientific certainty on the magnitude of both the probable health risks and the attributed increases in animal origin food production makes the formulation of a solution to this perplexity and dilemma even more cumbersome.

Strategies to Reduce Antibiotic Usage in Animal Husbandry

The following solutions can potentially reduce the antibiotic consumption globally:

1. Reduce unnecessary use of antibiotics in agriculture and their dissemination into the environment. The assumed benefits of antibiotics used as growth promoters in animal feed can be achieved by improved cleanliness of animal houses [87,88]. Improved hygiene also has a moral imperative for the welfare of domesticated animals.
2. The systems combining surveillance (Antimicrobial Resistance Monitoring System) and regulation (Hazard Analysis and Critical Control Point, HACCP), covering farm to fork should be enforced effectively. Regulations have been the principal instrument to limit antimicrobial use in animal production. A global regulation putting a cap of using 50 mg of antimicrobials/kilogram of animal product/ year, could reduce total global consumption of antimicrobials by 64% [30].
3. Promote low-animal-protein diets. Recently, Republic of China has revised its dietary guidelines and recommends that the nation's 1.3 billion population should consume between 40g to 75g of meat per person each day. If followed this measure not only reduce the greenhouse gas emissions but could also have an indirect but substantial impact on the global consumption of veterinary antimicrobials [88]. According to Van Boeckel et al. [30], restricting the intake of meat to 40g/person/day could reduce global consumption of antimicrobials in food animals by 66%.
4. Charging a user fee on sales of antibiotics for non-human use from veterinary drug users can significantly dissuade non-judicious use of antibiotics [90]. This type of approach has also been supported by World Bank [91]. The revenues generated from such system can be diverted to support research on new antimicrobials, vaccines and diagnostics along with improvement in livestock rearing practices [92]. According to one estimate, imposing a user fee of 50% of the current price on veterinary antibiotics could reduce global consumption by 31% [30].

Although, all the strategies suggested here to address this issue are not exhaustive and mutually exclusive but if all these are considered in combination; they may possibly reduce the global consumption of antimicrobials in animals by up to 85%.

Conclusions

Antibiotics are indispensable tools for the treatment of various old as well as emerging infectious diseases. However, there are conclusive evidences which suggest that the indiscriminate and sub therapeutic usage of antibiotics not only in animal husbandry practices but also in human medicine has led to the emergence of antibiotic resistant pathogenic organisms. This is now considered as a major public health issue across the globe and therefore, is being addressed at every critical point of decision. The first restriction to use the antibiotics has been placed on food producing animals. The addition of antibiotics in animal feed and its direct relationship with human health hazards is somewhat misleading. But keeping in view the magnitude of problem, such stern actions has to be considered for betterment of mankind and survivability of human race. However, it might be just impossible to impose a blanket ban on the use of antibiotics in animal husbandry farms in a global scale. But close monitoring of the situation is imperative everywhere to avert or restrain emergence of resistant strains. Moreover, all antibiotic use needs to be evaluated and carefully controlled to preserve antibiotics as a healthcare tool in people and animals. Other control measures include improvements in food hygiene to reduce the spread of zoonotic bacteria to human via the food chain, ban on over the counter sale of antibiotics, development of novel opportunities to combat antimicrobial resistance and improvement in animal husbandry and managemental practices. To specifically address the issue in animal health, the livestock industries and associated professional must reduce and refine the use of antibiotics in animal production and replace antibiotics with other alternative disease control measures as much as possible. In addition, the medical profession must control misuse and overuse of antibiotics in hospitals and community practice. Although it is an inevitable consequence of the evolutionary adaptation of microbes; use and misuse of antimicrobial drugs by the humans have driven the increasingly rapid and prevalent emergence of resistance in a range of pathogenic and commensal organisms. So all in all, action plans to tackle this issue both at national and global levels stress the need for a holistic 'One Health' approach.

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Employment generation through fisheries based farming system in rural areas of Jammu region

Raj Kumar[1], A. Gupta[2], S. Masud[3], J.S. Manhas[4]

[1]Assistant Professor (SS) Fisheries [2]Associate Professor/Senior Scientist (Fisheries) [3]Associate Professor, Farming System Research Centre, [2]Associate Professor, Division of Agri. Extn. Education, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Chatha, Jammu, Jammu and Kashmir 180009, India.

Keywords:

Aquaculture;
Rural Employment;
Carp;
Fisheries Based Farming System.

Abstract

In hill states where opportunities of employment are very limited, fisheries and aquaculture can play an important role for the enhancement of farmer's income. Besides due to great portion of population comes under non-veg category, there is huge demand of fishes and other animal proteins. The gap of fish production and consumption pattern is also very big. In Jammu and Kashmir, total annual fish production is around 20,000 tons only while the consumption pattern of the entire state is very much higher. For fulfilling the animal protein demands, state has to depend on other states of country. A great portion of fish demand is being met by importing these from other states.

Introduction

Fish culture is very profitable and enjoyable business. It provides the economic and nutritional benefits to the mankind since time immemorial. Fish are rich sources of protein, essential fatty acids, vitamins and minerals. The fats and fatty acids which are present in fish, particularly Omega 3 fatty acids, are highly beneficial and are difficult to obtain from other food sources. Fish is essentially an Asian farming practice. India is endowed with vast and varied aquatic resources, of which only a small portion is being utilized for aquaculture practices.

Aquaculture continues to increase in volume and value of output in many countries of the world, filling the gap between the supply and demand for fish and fishery products, improving nutrition and contributing to the household economy, particularly in rural areas. There is immense scope for the betterment of mankind through aquaculture. The growing gap between supply and demand globally will impact on the health and nutrition of low income families, unless efforts are made to increase the production to meet the growing demand.

Fish culture/Aquaculture

Aquaculture is a new name for what once we called 'fish culture'. It covers the culture of all commercially important aquatic organisms which involves aquatic animals such as fishes, crustaceans, mollusks as well as aquatic plants such as sea weeds under controlled conditions. Aquaculture continues to increase in volume and value of output in many countries of the world, filling the gap between the supply and demand for fish and fishery products, improving nutrition and contributing to the household economy, particularly in rural areas.

Objectives

The main objectives of aquaculture are:

1. To boost the economy of the country by way of increasing per capita fish production and income.
2. To generate employment opportunities for the unemployed and under employed persons.
3. To utilize full potential of the natural water resources available in the country.
4. To uplift the socio-economic status of the farmers.

Corresponding Author: Raj Kumar Gupta, Assistant Professor (SS) Fisheries, Farming System Research Centre, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Chatha, Jammu, Jammu and Kashmir 180009, India.
E-mail: rajpaba77@gmail.com

5. To earn foreign exchange revenue by transport of fish and fish products to foreign countries.
6. To boost the ornamental fish industry for overall economic development.
7. To culture the larvicidal fishes for control of mosquito larvae.
8. To increase production of protein food, in the form of fish, and fulfill the increasing demands of nutritious food.

Levels of Aquaculture

Depending on the intensity of operation and degree of management, aquaculture practices are classified into following four levels:-

Extensive aquaculture

In extensive level of aquaculture, low stocking densities of 2000-5000 carp fingerlings are used and no supplemental feed is given. Fertilization may be due to stimulate the growth and production of natural food in the water. In such types of culture system, carp culture does not require water exchange during culture period. The ponds used for extensive aquaculture are usually large. The production is generally low, less than 0.5 ton/ha/yr in the case of carps.

Semi-Intensive Level

Semi-intensive aquaculture uses medium size ponds 0.5 ha each with comparatively higher stocking densities than extensive aquaculture (5000-10000 carp fingerlings/ha). Supplementary feeding is done in moderate amounts. In carp culture, water replenishment is done once or twice a month@10%. The production averages around 3-7 tons/ha/yr of carps. Semi-intensive level of aquaculture is most commonly used in all over the country.

Intensive Level

In intensive level of aquaculture, the pond size is generally small (about 0.2 ha approximately) with very high density of culture organisms i.e. 20000 to 25000 carp fingerlings/ha are stocked. The system is totally dependent on the use of formulated feeds. Feeding of the stock is done at regular intervals. Water replacement under intensive culture is effected on a daily basis. Production under intensive level of aquaculture is much higher, for example, about 12 to 15 tons/ha/year in carp culture.

Super-intensive level

Super intensive aquaculture needs running water supply and complete daily water exchange is performed. This system is mostly practiced in cement tanks, fiberglass tanks and raceways etc. which are fitted with high efficiency biological filters for continues recirculation of water. The size of the tank ranges between 50-100m^3. The cultured organisms are fed with high quality formulated feed. The feed is given through demand feeders. The water quality is regularly monitored with electronic gadgets. Stocking density ranges between 40,000 to 50,000 carp fingerlings/ha. The production ranges between 15-20 tons/ha/yr in case of carps.

Importance of Aquaculture

- Integration of fish farming with agriculture and/or animal husbandry is known to be more profitable than agriculture alone.
- Fish culture gives efficient means for recycling agricultural and domestic wastes, in order to help/protect our environment
- Many high valued and commercially important aquatic items such as trout, ornamental fish and many other may helps in earning good returns.
- Artificial recruitment in the water bodies by fish seed produced in fish hatcheries through aquaculture (ranching), could certainly add new fishery resources or increase existing fish stocks.
- Through Aquaculture, we can utilize the unutilized large size water bodies for fish production by adopting pen/cage culture types of culture systems.
- Aquaculture could help in generating employment for many unemployed and under-employed people. Such a step would help to stop the migration from villages to urban areas.
- Besides, from human nutrition point of view, the fish food is not only easily digestive but is also rich in essential amino acids like lysine and methionine. The unique poly unsaturated fatty acids (PUFA) namely, eicosa pentaenoic acid of fish is known to reduce the cholesterol level of blood and save human beings from coronary diseases. Further, vitamins and minerals are also present in good quantities in fish.

Factors to be kept under consideration for doing a successful fish culture

- The major factors to be considered are soil type, topography and water supplies.

- The soil type influences how well the ponds will hold water; soils which have the water holding capacity, are preferred for pond construction because it prevents leakage. The good quality soil containing a lower limit of 20 percent clay is necessary for making ponds.
- The topography determines the size and shape of the ponds. The ponds should not be more than 10 feet depth. For better management, the size of the ponds should not be too much bigger. Sites, where huge individual ponds could be built, can be divided into smaller ponds built in series. The ponds should be rectangular in shape
- The availability and quality of water determine where and what type of pond should be made. Growing and harvesting are more challenging in case of erratic water supplies. A perennial water source is very much necessary for the successful fish culture. Source of water may be canal, stream, river, lake, or bore well.

Characteristics of a Candidate Species

The species to be selected for aquaculture should have following characteristics:

1. It should have high growth rate
2. It should have capabilities of efficiently utilize and convert the organic production of the water into fish flesh
3. It should be compatible with other species under culture
4. It should be hardy to live in changing physico-chemical conditions such as temperature, pH, turbidity, carbon dioxide and dissolved oxygen.
5. Able to reproduce under confined conditions
6. It should be easy to handle and harvest
7. It should have good market demand

In carp culture, usually three Indian major carps viz. *Catla catla, Labeo rohita and Cirrhinus mrigala* and three exotic carps such as *Hypophthalmichthyes molitrix, Ctynopharyngodon idella and cyprinus carpio* are selected for culture.

This is mainly because of their fast growth and compatibility among each other. However in some temperate areas of state only three exotic carps viz. *Hypophthalmichthyes molitrix, Ctynopharyngodon idella and Cyprinus carpio* are selected for carp culture due to lower temperature. Besides, in cold belts, trout culture mainly of rainbow trout is also in practice.

Culture Systems

Aquaculture is practiced through various culture systems/methods. Freshwater aquaculture is carried out in fish ponds, fish pens, fish cages, raceways and on a limited scale in paddy fields. However, fish culture in ponds is the oldest form of aquaculture and at present, it is the only culture system which is mainly adopted by the farmers for carp culture. Here we will discuss some important points about the ponds culture system.

Ponds Culture system for carp

It is the most common method of fish culture. Water is maintained in an enclosed area by artificially constructed ponds where the aquatic animals such the finfish and shellfish are reared. The ponds may be filled with canal water, rain water, bore well water or from other water sources. The pond must be constructed after proper site selection. The climate, topography, water availability and soil quality of the region influence the character of the fish pond.

Detailed knowledge regarding different types of fish ponds is a prerequisite for a profitable business in fish culture. A fish farm comprises of different types of ponds namely nursery ponds, rearing ponds, production ponds and breeding ponds etc. The number and dimensions of these ponds mainly depends upon the water resource, variety and size of fish to be cultured and type of management. A typical fish pond is a drainable water body with an inlet for the entry of water from water source and an outlet for draining the pond during harvest.

Types of Fish ponds

Nursery Pond

Nursery ponds are smaller (0.02-0.06 ha) and is mainly prepared to nurse the hatchlings for a period of about two to three weeks i.e. until they become fry (2.5-4.0 cm). The depth of the water column may be between 1.0 1nd 1.5 m. The maximum stocking density of hatchlings is about 10 millions/ha. However these ponds are used as nursery only for a short time, they could be used three or four times in a single breeding season. During the other seasons, the nurseries can also be used as production ponds.

Rearing Ponds

Rearing ponds are fairly larger than nursery ponds and sizes usually range between 0.06 and 0.1 ha. In these, the fry are grown for about two to three months or until they attain fingerlings stage

(4-10 cm). The depth of water column may be between 1.5 and 2.0 m. Like nursery ponds, when rearing ponds are not in use for rearing purpose, they can serves as production ponds

Production Ponds

In production/stocking ponds, the fingerlings are raised to marketable size fish. The size of this pond varies from 0.1 to 2.0 ha, as ponds larger than 2 ha are not suitable for efficient management. In production ponds for carp culture, the depth of water column should be between 2 and 2.5 m.

Breeding Ponds

These ponds are only needed for breeding purposes. These are used to stock brooders of the fish species to breed.

In case the source of water is turbid, a small sedimentation pond or a filtration system may also be constructed to filter the water before its direct entry into the fish ponds. If areas of water scarcity and high seepage are to be utilized for fish farming, cemented ponds may be constructed there. However, such ponds should be treated/overlaid with a soil bed/ cover of 30-50 cm soil, in order to give the natural substratum with rich organic matter for higher production and growth.

General management practices for fish culture

The management practices of fish ponds includes mainly the clearing of algal blooms and weeds, eradication of unwanted animals including predatory and weed fishes by poisons, liming, fertilization, seed stocking, regular supply of required supplementary feed, regular monitoring of water quality parameters and fish livestock health as well as harvesting of table size fishes for marketing.

Clearance of algal blooms and aquatic weeds

During fish culture, algal blooms may appear. During night hours, these algal blooms along with different aquatic weeds liberate good amount of carbon dioxide and absorb the dissolved oxygen content available in the fish pond. It is reported that higher carbon dioxide concentration may be responsible for large scale fish mortality. They also compete with fish for nutrients as well as space and also create obstruction in free movement of fishes. Most effective method for the control of algal blooms is introduction of algae feeding fish such as silver carp. Aquatic weeds can be controlled either by manual/mechanical, chemical or biological methods. Mechanical method can be used against emergent and submerged weeds. When aquatic weeds are not controlled by manual/mechanical method, then they can be remove by applying chemicals like 2,4 D (for emergent weeds and grasses), Simazine, Diuron3 (for submerged weeds) or paraquat (against floating weeds). Aquatic weeds can also be controlled by biological method i.e. by using fish like grass carp @ 150 to 200 kg/ha in culture ponds. These fishes give production without damaging the natural pond ecosystem

Eradication of Predators and Weed Fishes

Presence of undesirable fishes may pose problem as they compete for food, oxygen, space and also prey upon the small seed stocked for culture. Such fishes may be controlled by repeated netting operations, application of mahua oil cake or complete pond drying (if possible).

Control of Predatory Aquatic Insects

Various types of insects either as larvae or adults may not only prey on fish hatchlings but may also compete for food. The most important insects which create problems to fish culture include the water strider, backswimmers, water scorpions, giant water bugs, diving beetles and nymphs of dragonflies. Repeated dragging through water with a fine meshed cloth net may help in the removal of these insects to some extent. However, application of cheap oil soap emulsion (3:1) has been found to be most effective for the control of aquatic insects.

Liming

Liming is done for maintaining soil and water pH. Besides, lime also acts as fertilizers. It should be done one week before fertilization. For a pond having pH around slightly alkaline, dose of lime should be 250-300 kg/ha/year.

Fertilization

We should fertilize the pond for production of natural food organisms and productivity. Fertilizers may be organic (cow dung@10-20 ton/ ha/year) or inorganic (urea@300-350kg/ha/year, single super phosphate@200-300kg/ha/yr). However dose should always be based on the condition and quality of pond water. For this, regular monitoring of pond water and fish health is very much necessary for any kind of fish culture.

Stocking of Fish Seed

One should keep in mind about the time, amount and ratio of stocking. Stock the fish early in the morning or evening or during cloudy days, because at that time water temperature is at minimum. Packed container should be kept for about half an hour in the pond water to equate the temperature. For production pond, stocking density for semi-intensive level of aquaculture should be 5000-10000 fingerlings/ha. There is always an optimum stocking rate in a particular situation, which gives the highest production and the largest fish. Under crowded condition at a higher stocking rate, fish may compete severely for the food supply, and thus suffer stress due to aggressive interaction. Fishes under stress eat less and grow more slowly. In static pond waters, too much of excretory products of the fish livestock suppress the growth rate of stock. However with efficient removal of such excretory products by the proper water circulation or aeration of the pond water, the fish production per unit area can be increased. Depending on the natural productivity of the pond, stock the different varieties of fish species in proper ratio. In case of three species combination, stocking ratio should be catla (40%), rohu (30%) and mrigal (30%) while in case of six species combination of IMC and exotic carps, stocking ratio should be catla (15%), silver carp (15%), rohu (20%), grass carp (15%), mrigal (15%) and common carp (20%). However, depending on the seed availability and other local conditions, the stocking ratios can be changed.

Supplementary Feeding

Feed the fish early in the morning and/or evening time. Artificial feed can be prepared either from animal source (fish meal, shrimp meal, silkworm pupae, poultry waste etc.) and/or vegetable source (groundnut oilcake, mustard oil cake, soybean oil cake, rice bran, wheat bran, wheat flour etc.). Supplementary feed should be given daily @1-3% of estimated body weight (biomass) of fish livestock present in the fish pond.

Health Management

Sometimes, due to high stocking densities and polluted feed or water, fish is prone to diseases. Most common symptoms of diseased fish are sleeping sickness, dots on body part, fin rottening, swelling of body, abnormal swimming, loosening of scale, gill rottening and fish comes to water surface. Precaution should be taken that diseased fish is not stocked, use healthy seed for stocking. After stocking, periodic sampling of fish can be done from pond for regular checking/supervision of the fish health and growth. Always use aqua medicines with the consultation of fisheries experts.

Harvesting

Under favourable conditions, Indian major carp as well as exotic carps attain the marketable size within one year time. After attaining the marketable size fish stock, lower the water level of pond by draining the excess water and harvest the stock with the help of a suitable net.

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Shelf life enhancement of muscle foods with biodegradable film packaging

Meena Goswami[1], Vikas Pathak[2], Sanjay Kumar Bharti[3], Anita Tewari[4], Anita Chappalwar[5], Tanuja[6], Sadhana Ojha[7]

[1]Assistant Professor [2]Professor and Head [3]Assistant Professor [5,6]PhD Scholar [7]MVSc Scholar, Department of Livestock Products Technology, College of Veterinary Sciences and Animal Husbandry, DUVASU, Mathura, Uttar Pradesh 281001, India. [4]Assistant Professor Department of Veterinary Public Health, College of Veterinary Science, Rewa, Madhya Pradesh, India.

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Abstract

Bio-based products and innovative process technologies are receiving attention in food industry to reduce the dependence on fossil fuel and move to a sustainable materials basis. Biodegradable films are continuous matrices prepared from edible materials made up of proteins, polysaccharides and lipids. Edible coatings are either applied to or made directly on foods while films are independent structures. A significant progress has been made in the development of biodegradable plastics, largely from renewable natural resources, to produce biodegradable materials with similar functionality to that of oil-based polymers. These natural films are preferred over non biodegradable films due to less carbon emission, less energy consumption, less landfill area and recycling ability. Incorporation of nano composites, essential oils, plant extracts, antimicrobial substances etc. improve functionality of bio degradable polymers based films in terms of protection against external factors and increase the food's stability through antimicrobial properties and/or responding to environmental changes.

Introduction

Packaging has been defined as a socio-scientific discipline which operates in society to ensure delivery of goods to the ultimate consumer of those goods in the best condition intended for their use (Lockhart, 1997).

Food packaging requires protection, tampering resistance, and special physical, chemical, or biological needs. It also shows the product that is labeled to show any nutritional information on the food being consumed. The packaging and labels can be used by marketers to encourage potential buyers to purchase the product. Package design has been an important and constantly evolving phenomenon for several decades.

Marketing communications and graphic design are applied to the surface of the package and (in many cases) the point of sale display. Packaging can play an important role in reducing the security risks of shipment. Packages can be made with improved tamper resistance to deter tampering and also can have tamper-evident features to help indicate tampering. Packages can have features which add convenience in distribution, handling, stacking, display, sale, opening, reclosing, use, and reuse. The fundamental reasons for packaging fresh and processed meat products are preventing contamination, delaying spoilage, permitting some enzymatic activity to improve tenderness, reducing weight loss, and retaining colour and aroma (Mondry, 1996; Brody, 2007).

As traditional food packaging materials show shortcomings in terms of their environmental pollution impact and in their manufacturing requirements for non-renewable resources, the need for alternative packaging materials and packaging formats is now required more than ever.

Recently, a series of new packaging technologies and materials have been developed including active

Corresponding Author: Meena Goswami, Assistant Professor, Department of Livestock Products Technology, College of Veterinary Sciences and AH, DUVASU, Mathura, (U.P), India. Pin-281001
E-mail: dr.goswami2008@yahoo.co.in

packaging, intelligent packaging, edible coatings/ films, biodegradable packaging, and nanomaterial packaging. These technologies and materials have the potential to improve the quality and safety, prolong the self-life, reduce the environment impact, and increase the attractiveness of the packaged product to the retailers and consumers, outcomes that are favourably welcomed by the food industry.

Current technologies for meat packaging

Packaging can lower the weight loss, cost of transportation and increase the shelf life of food products (Rozbeh *et al.*, 1993).

Packaging becomes active when it performs another desired role other than providing an inert barrier to external conditions and has developed as a series of responses to maintain quality and safety of food (Rooney, 2005).

Fresh packed meat has been one of the major meat products in the market since early in the 1900's (Cerisuelo *et al.,* 2013). Packaging delays meat quality deterioration such as microbial proliferation, discoloration, off-flavor, and nutrient loss (Zhou *et al.,* 2010).

Edward *et al.* (1987) reported that among vacuum packaging, aerobic packaging and modified atmosphere packaging, vacuum packaging was the most widely used for extruded products as this type of packaging could keep the product safe especially beef products for about 45 days at ambient temperature ($32+2^0$C).

Avilés *et al.* (2014) compared the color stability of beef steaks under vacuum packaging and re-packaging after leaks. They reported that repeated vacuum packaging should be avoided as it adversely affected color stability of product.

Zakrys *et al.* (2009) reported that modified atmospheric packaging (MAP) in beef was preferred by consumers because of their increased tenderness and juiciness compared with steaks packaged in traditional tray packaging. Cornforth and Hunt (2008) used anaerobic MAP with low levels (about 0.4%) of CO, 20-30% CO2 and the remainder N2 and observed that CO MAP maintained the red color stability of steaks not only during storage but also after opening the packages (Liu et al., 2014).

Zhou *et al.* (2012) designed an active packaging film for chilled meat by employing polyvinyl acetate (PVA) and polylactic acid (PLA) as film-forming materials and sustained-release microcapsules containing natural antimicrobial agent. They averred that antimicrobial agent was slowly released from the microcapsules, migrated in the film and finally reached the surface of the chilled meat to achieve antimicrobial and fresh-keeping effects. In the last few decades, there has been a marked increase in the use of natural polymer-based film materials and coatings in packaging for food industry, which protect food from external contamination, retarding its deterioration by extending its shelf-life and maintaining its quality and safety (Malhotra *et al.*, 2015).

Biodegradable film packaging

Edible coatings or films are defined as continuous matrices prepared from edible materials made up of proteins, polysaccharides and lipids. They can be used to incorporate functional food substances, such as antimicrobials, antioxidants, flavouring agents and nutrients, to improve safety, stability, sensory, and nutritional properties of foods (Lin and Zhao, 2007; Silva-Weiss *et al.,* 2013).

There is a growing demand by consumers for foods perceived as natural, fresh-tasting, nutritious, healthy and safe, including meat and meat products (Grunert and Valli, 2001).

Bio degradable films have received considerable attention in recent years because of their advantages including use as edible packaging materials over synthetic films.

The primary factors driving development of the biodegradable packaging market include the increase in crude oil prices, which has narrowed the price differential, other key factors include consumer demand, the proliferation of convenience packaging, the development of new applications for bioplastics and the increased economic viability as production ramps up and unit costs decrease (Pawar and Purwar, 2013).

Bio degradable films can be produced either by wet processing or dry processing. For wet processing films can be produced from materials with film forming ability. During manufacturing, film materials must be dispersed and dissolved in a solvent such as water, alcohol or mixture of water and alcohol or a mixture of other solvents. Plasticizers, antimicrobial agents, colors or flavors can be added in this process. Adjusting the pH and/or heating the solutions may be done for the specific polymer to facilitate dispersion. Film solution is then casted and dried at a desired temperature and relative humidity to obtain free standing films. Film solutions can be applied to food by several methods such as dipping, spraying, brushing and panning followed by drying. The dry process does not involve solvent dispersion as it relies on inherent thermoplastic characteristics of some biopolymers and is produced by compression, molding or extrusion (Liu *et al.,* 2014).

Biopolymers such as polysaccharides, proteins and lipids can be used alone or in combination to form coatings and films, the physical and chemical properties of the base materials, greatly influencing the functionality of the films and coatings produced. The choice of materials is generally based on their water solubility, hydrophilic and hydrophobic nature, easy formation into coatings and films, sensory properties, and targeted applications.

Polysaccharide-based biodegradable films

Polysaccharides, such as cellulose and its derivatives, starch, chitosan, and pectin have been commonly used to make edible coatings and films. Polysaccharide based coatings and films provide a good barrier to O_2 and CO_2, but a poor barrier to water vapor due to their hydrophilic nature (Vargas *et al.,* 2008).

Polysaccharide coatings are colorless, have an oily-free appearance and a minor caloric content and can be applied to pro-long the shelf life of fruits, vegetables, shellfish or meat products by significantly reducing dehydration, darkening of the surface and oxidative rancidity (Hassan *et al.,* 2018).

Cellulose and derivatives - Cellulose is the most abundant natural biopolymer on earth. It is composed of D-glucose units through β-1,4 glycosidic bonds, and is insoluble in water in its native form. The water solubility of cellulose can be improved by alkali treatment to swell the structure, followed by reaction with chloroacetic acid, methyl chloride, or propylene oxide to yield carboxy methyl cellulose (CMC), methyl cellulose (MC), hydroxyl propyl methyl cellulose (HPMC), or hydroxypropyl cellulose (HPC) (Lin and Zhao, 2007).

Chitosan and derivatives - Chitosan, one of a few natural cationic polysaccharides, is the N-deacetylated derivative of chitin. Chitin exists in three morphologically distinct forms as α, β, and γ. α-Chitin is mainly sourced from shrimp, crab, and krill shells, β-chitin is sourced from squid pens, and γ-chitin is usually derived from fungi and yeast. Chitosan-based coatings and films have selective permeability to O_2 and CO_2, and good mechanical properties, but high water vapour permeability (Elsabee and Abdou, 2013).

Pectin - Pectin, a complex group of structural polysaccharides found in plants, is mainly composed of Dgalacturonic acid polymers with varying degrees of methyl esterification (Deng and Zhao, 2011).

Protein based biodegradable films

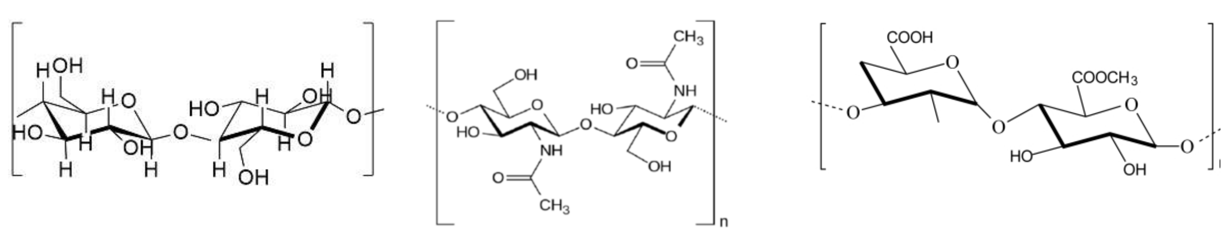
Protein-based edible films are generally formed from solutions or dispersions of the protein as the solvent/carrier evaporates. The solvent/carrier is generally limited to water, ethanol or ethanol-water mixtures.

Generally, proteins must be denatured by heat, acid, bases, and/or solvents in order to form the more extended structures that are required for film formation.

Proteins of both plant and animal origin can form coatings and films with good mechanical properties and O_2 and CO_2 barrier functionality, particularly at low relative humidity. Corn zein coatings and films possess a good oxygen barrier and relatively good water barrier properties.

However, plasticizers are required to improve the extensibility of the films. Soy protein as soy protein concentrate (SPC, 70% protein) or soy protein isolate (SPI, 90% protein) have been made into coatings and films with potent oxygen barrier but poor moisture barrier properties due to the inherent hydrophilicity of the proteins.

Wheat gluten protein is soluble in aqueous alcohol, but alkaline or acidic conditions are required for the formation of homogeneous coatings or films. These coatings and films have high water permeability due to their hydrophilic nature but are good barriers to O_2 and CO_2 (Baldwin, 2007).



Cellulose | Chitosan | Pectin

Fig. 1: Chemical structure of carbohydrate based biodegradable films

Collagen is used to make the most commercially successful edible protein films. It is biocompatible and non-toxic to most tissues and has well-documented structural, physical, chemical and immunological properties.

Collagen can be processed into a variety of forms; and it is readily isolated and purified in large quantities. Gelatin is unique among hydrocolloids in forming a thermo-reversible substance with a melting point close to body temperature, which is particularly significant in edible and pharmaceutical applications. It can form flexible, clear, strong and oxygen permeable films by formation of ionic crosslinks between amino and carboxyl groups of amino acid side chains, when dissolved in aqueous solutions, (Nur Hanani *et al.*, 2014).

Caseinates films are made from aqueous solutions without heat treatment due to their random coil nature. Interactions in the film matrix are likely to include hydrophobic, ionic, and hydrogen bonding (Avena-Bustillos and Krochta, 1993).

Lipid-based Biodegradable Films

Lipid based coatings and films are very effective moisture barriers due to their hydrophobic character, and are used primarily to inhibit moisture loss from foods and to improve consumer appeal by adding a glossy finish to the treated products.

Most fatty acids, such as capric, lauric, myristic, oleic, palmitic, and stearic acids, that are derived from vegetable oils are considered GRAS, and are commonly used with glycerides as emulsifiers in the preparation of edible coatings and films (Baldwin, 2007).

Resin (e.g. shellac and terpene resin) based coatings generally have lower permeability to O_2, CO_2 and ethylene gas, and moderate permeability to water vapour. Coatings incorporated with lipids are generally a good solution owing to their stability.

However, they can also negatively affect the sensory parameters leading a waxy sensation (Galus and Kadzinœka, 2015).

Lipid-based coatings and films provide a good moisture barrier, but poor mechanical properties, poor adherence, a greasy surface, waxy taste and lipid rancidity may occur. Lipids are usually applied in combination with polysaccharides or proteins to form composite coatings and films for taking advantage of the special functional characteristics of each component (Furkan *et al.*, 2017).

Advancement in Biodegradable Films

The combination between polymers to form films could be from proteins and carbohydrates, proteins and lipids, carbohydrates and lipids or synthetic polymers and natural polymers.

The main objective of producing composite films is to improve the permeability or mechanical properties as dictated by the need of a specific application (Bourtoom, 2008).

Various materials can be incorporated into protein films to influence the mechanical, protective, sensory, or nutritional properties. Plasticizers are additives that are an important class of low molecular weight non-volatile compounds that are widely used in polymer industries. The primary role of such substances is to improve the flexibility and capacity for processing of polymers by lowering the second order transition temperature, the glass transition temperature (Tg) (Wittaya, 2013).

Edible coatings and films can provide multiple functions for meat and meat product packaging. There is increased interest in the development and usage of antimicrobial edible coatings and films to preserve meat quality for longer shelf life and improved food safety.

Antimicrobial agents commonly incorporated into edible coatings and films for meat and meat products include organic acids (lactate and acetate, malic acid, propionate, and p-aminobenzoic acid), essential oils and plant extracts (lemongrass, oregano, pimento, thyme, or cinnamon), bacteriocins (nisin, pediocin), enzymes (lysozyme), chitosan and lauric arginate (Sung *et al.*, 2013).

Baranenko *et al.* (2013) developed chitosan coatings with gelatin, distarch glycerol, wheat fibre, sodium alginate, or guar gum in various ratios and applied them to the surfaces of retail cuts of veal and rabbit meat, boiled sausages, smoked sausages and smoked-boiled pork brisket stored at 4±1°C. All coatings reduced the total viable counts of microorganisms compared to uncoated samples. Coatings based on 2% chitosan and 2% gelatin solution in a ratio of 1:1 showed the strongest bacteriostatic effect against *B. subtilis, S. aureus* and *E. coli*. Combined application of vacuum and protective coatings provided the strongest suppression effect in all samples.

Nano composites (NCPs) are novel polymers formed by extruding blends of polysaccharides, proteins and/or lipids or by laminating two or more edible films or by emulsion formation, which have essentially been incorporated with nanoparticles. The microstructure of composites consists of a continuous phase and a discontinuous phase or filler (Matthews and Rawlings, 1994).

The continuous phase or matrix is formed by the polymer while the discontinuous phase or filler may be the active components like antioxidants or antimicrobials or metals or ions. In nano-composites the filler material/nano-components or materials have at least one dimension smaller than 100 nm (Neethirajan and Jayas, 2011).

Nanotechnology has been used to generate new products with desirable characteristics such as enhanced shelf-life, delayed spoilage and protection from food-borne pathogens (Ozcalik and Tihminlioglu, 2013).

Challenges and Opportunities

Biodegradable packaging is not the answer to all plastic packaging solutions. Cellulose derivative films are poor water vapor barriers because of the inherent hydrophilic nature of polysaccharides and they possess poor mechanical properties. One method of enhancing the moisture barrier would be by incorporation of hydrophobic compounds such as fatty acids into the cellulose ether matrix to develop a composite film like hydroxypropyl methylcellulose (HPMC) (Dhanapal *et al.,* 2012).

However, again there are difficulties in preparing a homogenous composite film with both hydrophobic and hydrophilic compounds. Chitosan was the second most abundant natural and nontoxic polymer in nature after cellulose and form translucent films to enhance the quality and extend the storage life of food products (Ribeiro *et al.,* 2007).

However, chitosan products are highly viscous, cohesive and compact and the film surface has a smooth contour without pores or cracks. The poor electrical conductivity of hydrogen results in a poor response time and a high operating voltage limits its applicability in chitosan based sensor devices. Hence, composites have been attempted by incorporating a rigid conducting polymer (such as PANI) into a flexible matrix (such as chitosan) to combine the good possibility of the matrix and the electrical conductivity of the conductive polymer (Xu et al., 2006).

The amount of energy used to actually process these materials has also been questioned in regards to how environmentally-friendly the technology is. While nanotechnology could improve the material's performance characteristics, the jury is still out as to whether it is actually biodegradable. Compostable materials refer to those that can degrade in a natural environment and is the most environmentally-friendly package to date.

However, the materials are yet to be produced at processing speeds sufficient for large quantities. Biodegradable products have been available for quite some time but usually at a much higher cost or reduced performance characteristics when measuring moisture or oxygen barrier properties, or even temperature resistance.

Conclusion

Natural polymers are an alternative source for packaging development due to their precise taste and biodegradability. Biodegradable edible polymers have appeared as a substitute for synthetic plastic for food applications and have received significant attention in recent years because of their advantages over synthetic polymer.

Nowadays, nanotechnologies are being used to enhance the nutritional features of muscle foods by means of nanoscale additives and nutrients and nanosized delivery systems for bioactive polymeric compounds. Micro- and nanoencapsulation of active compounds with edible polymer coatings may help to control their release under specific conditions, thus protecting them from moisture, heat, or other extreme conditions and enhancing their stability and viability.

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Indian Journal of Anatomy	Bi-monthly	8500	8000	664	625
Indian Journal of Ancient Medicine and Yoga	Quarterly	8000	7500	625	586
Indian Journal of Anesthesia and Analgesia	Monthly	7500	7000	586	547
Indian Journal of Biology	Semiannual	5500	5000	430	391
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Indian Journal of Communicable Diseases	Semiannual	8500	8000	664	625
Indian Journal of Dental Education	Quarterly	5500	5000	430	391
Indian Journal of Emergency Medicine	Quarterly	12500	12000	977	938
Indian Journal of Forensic Medicine and Pathology	Quarterly	16000	15500	1250	1211
Indian Journal of Forensic Odontology	Semiannual	5500	5000	430	391
Indian Journal of Genetics and Molecular Research	Semiannual	7000	6500	547	508
Indian Journal of Hospital Administration	Semiannual	7000	6500	547	508
Indian Journal of Hospital Infection	Semiannual	12500	12000	938	901
Indian Journal of Law and Human Behavior	Semiannual	6000	5500	469	430
Indian Journal of Legal Medicine	Semiannual				
Indian Journal of Library and Information Science	Triannual	9500	9000	742	703
Indian Journal of Maternal-Fetal & Neonatal Medicine	Semiannual	9500	9000	742	703
Indian Journal of Medical & Health Sciences	Semiannual	7000	6500	547	508
Indian Journal of Obstetrics and Gynecology	Bi-monthly	9500	9000	742	703
Indian Journal of Pathology: Research and Practice	Monthly	12000	11500	938	898
Indian Journal of Plant and Soil	Semiannual	65500	65000	5117	5078
Indian Journal of Preventive Medicine	Semiannual	7000	6500	547	508
Indian Journal of Research in Anthropology	Semiannual	12500	12000	977	938
Indian Journal of Surgical Nursing	Triannual	5500	5000	430	391
Indian Journal of Trauma & Emergency Pediatrics	Quarterly	9500	9000	742	703
Indian Journal of Waste Management	Semiannual	9500	8500	742	664
International Journal of Food, Nutrition & Dietetics	Triannual	5500	5000	430	391
International Journal of Neurology and Neurosurgery	Quarterly	10500	10000	820	781
International Journal of Pediatric Nursing	Triannual	5500	5000	430	391
International Journal of Political Science	Semiannual	6000	5500	450	413
International Journal of Practical Nursing	Triannual	5500	5000	430	391
International Physiology	Triannual	7500	7000	586	547
Journal of Animal Feed Science and Technology	Semiannual	78500	78000	6133	6094
Journal of Cardiovascular Medicine and Surgery	Quarterly	10000	9500	781	742
Journal of Forensic Chemistry and Toxicology	Semiannual	9500	9000	742	703
Journal of Geriatric Nursing	Semiannual	5500	5000	430	391
Journal of Global Public Health	Semiannual				
Journal of Microbiology and Related Research	Semiannual	8500	8000	664	625
Journal of Nurse Midwifery and Maternal Health	Triannual	5500	5000	430	391
Journal of Organ Transplantation	Semiannual	26400	25900	2063	2023
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Journal of Pharmaceutical and Medicinal Chemistry	Semiannual	16500	16000	1289	1250
Journal of Practical Biochemistry and Biophysics	Semiannual	7000	6500	547	508
Journal of Psychiatric Nursing	Triannual	5500	5000	430	391
Journal of Social Welfare and Management	Triannual	7500	7000	586	547
New Indian Journal of Surgery	Bi-monthly	8000	7500	625	586
Ophthalmology and Allied Sciences	Triannual	6000	5500	469	430
Otolaryngology International	Semiannual	5500	5000	430	391
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Physiotherapy and Occupational Therapy Journal	Quarterly	9000	8500	703	664
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Urea treated paddy straw: Effect on feed intake, digestibility, fermentable energy and milk production in cattle

S. Sivajothi[1], P. Aruna[2], B. Sudhakara Reddy[3]

[1]Assistant Professor, Department of Veterinary Parasitology [2]Assistant Professor, Faculty of Agronomy, Livestock Farm Complex [3]Assistant Professor, Faculty of Veterinary Medicine, Department of Veterinary Clinical Complex, College of Veterinary Science, Sri Venkateswara Veterinary University, Proddatur, Andhra Pradesh 516360, India.

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Paddy Straw;
Utilization;
Feed, Ruminant, Urea

Abstract

Most of the small scale farmers in the developing counties like in India are cultivating the rice. Paddy straw is by-product of the rice production. Paddy straw was rich in lignin content and reduces the degradability by ruminal microorganisms in cattle. Different methods including physical, chemical and biological are available, to improve the paddy straw utilization as feed stuff to the cattle. Among the several methods, treating with urea is one of the commonest methods following in the field. To improve the quality of paddy straw by its availability of the crude protein, digestibility, rumen degradability and production of high milk yield treatment with urea is recommended. The present review about an overview of existing knowledge on urea treated paddy straw and its benefits as cattle feed.

Introduction

Ruminants are depending on the year - round grazing or hand fed in the tropical regions in the world. Due to presence of the seasonal dry periods, availability of pasture reduced for feeding which leads to lowered digestible energy and nitrogen, less milk production (Reddy, 1996). Paddy straw is considered as the most abundant source of feed for the animals during the dry periods (Anshar *et al.*, 2015). Supplementation of the poor quality straw and decomposed hay leads to development of the digestive disturbances including alkaline indigestion in cattle (Reddy and Kumari, 2010). Physical, chemical and biological treatments are the recommended procedures to improve the quality of the paddy straw (Selim *et al.*, 2004). It is essential to supplement the high quality nitrogen supplementation when cattle were suffering with infectious diseases including haemoprotozoan diseases (Sivajothi *et al.*, 2014). When cattle are suffering with gastro intestinal functional abnormalities in association with other systemic diseases, it is recommended the high nutritive value and easily digestible feed supplementation (Reddy *et al.*, 2014). Feeding of the paddy straw to the cattle had some limitations like low nitrogen content, the presence of lower carbohydrate content, limiting voluntary intake and reducing degradability by ruminal microorganisms (Rehrahie and Ledin, 2001, Trach *et al.*, 2001, Mesfin and Ktaw, 2010). The present review about an overview of existing knowledge on urea treated paddy straw and its benefits as cattle feed.

Importance of Urea Treated Paddy Straw

Feeding of the plain paddy straw does not provide enough nutrients because of its relatively low nutritive value, protein levels (2 to 5%), high fiber and lignin contents (NDF > 50%) and low digestibility in the rumen (< 60%) (Wanapat *et al.*, 2009). The practical utility of plain paddy straw was reduced because of the low feed intake by the cattle and low digestibility by the ruminants (Males, 1987). Urea treated paddy straw found to be improving the digestibility, nitrogen content, cellulose and hemicellulose levels (Silva and

Corresponding Author: S. Sivajothi, Assistant Professor, Department of Veterinary Parasitology, College of Veterinary Science, Sri Venkateswara Veterinary University, Proddatur, Andhra Pradesh 516360, India.
E-mail: sivajothi579@gmail.com

Orskov, 1988). Initially to improve the quality of paddy straw application of the caustic soda was trailed (Lehmann, 1991). Khan *et al*. (1999) studied the urea pre-treatment of straw by addition of the urease to improve the quality. It was proposed that the low quality roughages utility can be improved by the treatment with nitrogen sources, chemical and physical treatment (McDonald *et al.,* 2002; Nguyen *et al.,* 2012). Among the available treatment protocols for the paddy straw, urea treatment may be the most suitable method for small - scale farmers improve the quality of straws at the field level (Akter *et al.,* 2012).

Effect of Urea Treated Straw on Feed Intake

It was recorded that, higher intake of feed was noticed in the cattle after feeding with 4 kg urea with 1 kg calcium hydroxide to the paddy straw (Leng, 1984). Dajayanegra *et al*. (1989) and Ghana et al., (1993) reported both urea treatment and urea supplementation increased intake, a rate of digestion and digestibility of nutrients. Fadel, (2003) found that the treatment of urea and calcium hydroxide could slightly increase dry matter intake in dairy cows when compared with untreated rice straw. Ahmed *et al.* (2003) reported significantly higher dry matter intake in cattle feed with 4% urea treated straw.

Effect of Urea Treated Straw on Digestibility

Primary location of fiber digestion is rumen in cattle (Rai and Mudgal, 1988). It was proposed that feeding of urea as molasses blocks along with the paddy straw can improve the digestibility in ruminants (Leng, 1984). The proposed theory for improved digestibility due to as a result of increased straw degradability and better microbial activity, would cause a substantial improvement in digestibility and also involuntary intake (Fadel, 2003). Ahmed (2003) with that 4.0% urea + 4.0% soybean treated rice straw improved the co-efficient of digestibility of crude fiber. Wanapat *et al*. (2009) stated that urea treated paddy straw improve feed intake, digestibility and rumen ecology in cattle. Gunun (2013) explained the importance of the particle size of roughage to maintain the rumen ecosystem and it was associated with fiber digestibility and optimal pH for cellulolytic microorganisms.

Effect of Urea Treated Straw on Nutrient Content

Urea is one of the major chemical agents used to improve the nutritive value of cereal straws and other fibrous by-products (Ray *et al.,* 1989; Got *et al.,* 1991; Tune *et al.,* 1991). After treating with urea, it causes breaking of the ester bonds between lignin, hemicelluloses and cellulose, and finally all the fiber becomes enlarged. Urea ammonization affects CW composition and improves the extent of rumen degradability in the ruminants (Mason *et al.,* 1988; Many chi *et al.,* 1992). Khan *et al.* (1999) stated that addition of urease sources increased the rate of urea hydrolysis and crude protein content of treated straw. The increases of DM, OM, CP, a NDF and ADF digestibility in urea-calcium hydroxide treated rice straw treatments (Trach *et al.,* 2001). Malek *et al.* (2008) reported that the value for NFE of urease enzyme - treated group was lower than untreated rice straw group. Increase in the VFA levels was a reflection of the increase in the rumen fermentation which finally results in increased OMD and NDF (Trach *et al.,* 2001). Midau *et al.* (2015) reported the results of the urea - treated paddy straw and plain paddy straw and stated that, urea treated paddy straw had a higher crude protein value (12.35%) than the untreated paddy straw (3.22%).

Effect of urea treated straw on fermentable energy

Concentrate supplementation for such low - quality roughages also increases the rumen fermentation due to the supply of readily fermentable energy. However, it has been reported that high concentration levels in the diet may reduce rumen fermentation and rumination time (Korsakov and Ryle, 1990). Urea treatment of basal diets provided more fermentable energy and nitrogen to the rumen microbes than plain paddy straw (Tune *et al.,* 1991). Gunun (2013) reported that chemical treatments enhanced the nutritive value of rice straw through increasing the number of accessible sites of microbial attachment on the surface of the particles, increasing fibrinolytic microbe quantity and improving rumen fermentation characteristics.

Effect of Urea Treated Straw on Milk Production

Initially, Prasad *et al.* (1998) proved that by addition of the urea, fat content and the solids not fat production was increased along with the high milk production. Wanapat *et al.* (2009) recorded the higher concentration of the fat and protein in urea treated cattle than the plain paddy straw treated group of cattle. Midau *et al*. (2015) found the increase in milk yield along with the 3.5% FCM in the cattle feed with urea-treated rice straw than the control group in their study.

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Standard journal article

[1] Flink H, Tegelberg Å, Thörn M, Lagerlöf F. Effect of oral iron supplementation on unstimulated salivary flow rate: A randomized, double-blind, placebo-controlled trial. J Oral Pathol Med 2006; 35: 540-7.

[2] Twetman S, Axelsson S, Dahlgren H, Holm AK, Källestål C, Lagerlöf F, et al. Caries-preventive effect of fluoride toothpaste: A systematic review. Acta Odontol Scand 2003; 61: 347-55.

Article in supplement or special issue

[3] Fleischer W, Reimer K. Povidone iodine antisepsis. State of the art. Dermatology 1997; 195 Suppl 2: 3-9.

Corporate (collective) author

[4] American Academy of Periodontology. Sonic and ultrasonic scalers in periodontics. J Periodontol 2000; 71: 1792-801.

Unpublished article

[5] Garoushi S, Lassila LV, Tezvergil A, Vallittu PK. Static and fatigue compression test for particulate filler composite resin with fiber-reinforced composite substructure. Dent Mater 2006.

Personal author(s)

[6] Hosmer D, Lemeshow S. Applied logistic regression, 2nd edn. New York: Wiley-Interscience; 2000.

Chapter in book

[7] Nauntofte B, Tenovuo J, Lagerlöf F. Secretion and composition of saliva. In: Fejerskov O, Kidd EAM,

editors. Dental caries: The disease and its clinical management. Oxford: Blackwell Munksgaard; 2003. p. 7-27.

No author given

[8] World Health Organization. Oral health surveys - basic methods, 4th edn. Geneva: World Health Organization; 1997.

Reference from electronic media

[9] National Statistics Online—Trends in suicide by method in England and Wales, 1979-2001. www.statistics.gov.uk/downloads/theme_health/HSQ 20.pdf (accessed Jan 24, 2005): 7-18. Only verified references against the original documents should be cited. Authors are responsible for the accuracy and completeness of their references and for correct text citation. The number of reference should be kept limited to 20 in case of major communications and 10 for short communications.

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