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JOURNAL OF ANIMAL FEED SCIENCE AND TECHNOLOGY

January - June 2022
Volume 10 Number 1

Contents

Journal of Animal Feed Science and Technology (JAFST) (**ISSN 2321–1628)** is an extraordinary peer-reviewed journal publishing scientific research papers of international interest focusing on animal feeds and their feeding. The all papers in journal are describing research on feed for ruminants and non-ruminants, including all pet and aquatic animals.

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Original Article

Journal of Animal Feed Science and Technology
Volume 10 Number 1, January - June 2022
DOI: http://dx.doi.org/10.21088/jafst.2321.1628.10122.1

Socio-economic Profile Dairy Farmers Regarding the Scientific Animal Husbandry Practices followed by Dairy Farmers in Eastern Plain Zone of Uttar Pradesh

Ajay Kumar Gautam[1], H C Verma[2], R K Singh[3], R P Diwakar[4], Rajesh Kumar[5], Vibha Yadav[6], Mushtak Ahmad[7], Amit Kumar[8]

How to cite this article:

Ajay Kumar Gautam, H C Verma, R K Singh, et. al./Socio-economic Profile Dairy Farmers Regarding the Scientific Animal Husbandry Practices followed by Dairy Farmers in Eastern Plain Zone of Uttar Pradesh/ Journal of Animal Feed Science and Technology 2022;10(1):9–12.

Abstract

The present study was carried in Basti distract of out in Uttar Pradesh to assess socio-economic status dairy farmers regarding the scientific animal husbandry practices followed by dairy farmer in eastern plain zone of Uttar Pradesh. The state was purposively selected because scientific dairy farmers adopted by majority of rural farmers as a source of subsidiary income. The selection of District was purposively due to the researcher is well equated about the work, the socio-cultural status of the district which help in quick rapport building that is essential for authentic data collection. The selected Basti district four Blocks will be selected randomly. Three villages from each block were selected randomly. The villages were selected by applying simple random sampling technique. A village-wise list of dairy farmers were prepared and from that list, ten dairy farmers were selected randomly from each village, thus the final sample unit comprised of one hundred twenty (120) dairy farmers for this study. Majority (59.17%) of dairy farmer's belonged to old age group (>50 years), majority (25.83%) belonged to middle category, majority 58.33 per cent of the dairy farmers belonged to the other back word caste, majority 68.33 per cent of the dairy farmers were having nuclear family. majority (52.50%) of dairy farmers were in medium category of personal localite, information like family members, relatives, friends, Progressive farmers and others were used as source information in scientific dairy farming practices. Socioeconomic profiles like age, education, family size, family type and more social participation compression to other socioeconomic status have good scientific animal husbandry practices in research area

Keywords: Socioeconomic profile; Dairy farmer; Scientific; Animal Husbandry.

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Received on: 05.01.2022 **Accepted on:** 12.02.2022

Introduction

The livestock plays an important role in the economy of farmers. The farmers in India maintain mixed farming system i.e. a combination of crop and livestock where the output of one enterprise becomes the input of another enterprise thereby realize the resource efficiency. The livestock serves income, employment, social security, draft and dung. The livestock supports income and generates rural employment, especially for the landless, small and marginal farmers and women. More than 70% Indian rural people rear livestock and a majority of them are smallholders with less than 5 dairy animals (Birthal and Jha, 2005;). The overall contribution of livestock sector in total gross domestic product is nearly 4.11% at current prices during 2012-13 (anonymous, 2012). The milch buffaloes increased from 48.64 million to 51.05 million with an increase of 4.95% over previous census. (19th Livestock census, 2012). The total milk production in the country amounted to about 187 million metric tons that fiscal year (Statista Research Department, 2020)

Materials and Methods

The present study was carried in Basti distract of out in Uttar Pradesh to assess socio economic status dairy farmers regarding the scientific animal husbandry practices followed by dairy farmer in eastern plain zone of Uttar Pradesh. The information was generated from 120 dairy farmers, twenty dairy farmers from each of six selected villages. The information was generated regarding socio economic status dairy farmers regarding the scientific animal husbandry practices followed by dairy farmers. For this purpose of the study, three villages from each randomly selected block were randomly selected with lottery method by preparing the list of the village where sufficient number of dairy farmers was available. Total twelve villages selected from six talukas as below table.

Block wise selection of village

Blocks	Villages
Harraiya	Chapiya khurd, Chapiya Bujurg, Rajajot
Kaptanganj	Dubauli, Chaukahra, Bihra
Bahadurpur	Nagar khas, Chando, Bagiyapar
Vikramjot	Dhirauli Babu, Chatauna, Basewa Pandey
Total 4	**12**

Results and Discusion

Age

In Table 1 study revealed that the pooled mean age of the dairy farmers majority (59.17%) of the dairy farmers belonged to old age group (>50 years) age followed by the middle age group of (36-50 years) and young (<35 years) which accounts for 38.33 per cent middle age and 2.50 per cent young age group respectively. It was found that minimum age was 31 year highest ages was 70 year in the study area.

Education

Study revealed that the pooled mean education of the dairy farmer's majority (25.83%) belonged to middle category followed by the primary category which accounts for (21.67%) and (15.83%) secondary, 11.67 percent were up to the higher secondary, 10.00 percent and 4.17 percent were up to illiterate and functionally illiterate level of education respectively. These finding similar to the (Kaur and Rathoure, 2014) and Dayal et al., 2015.

Family type

In Table 1 study revealed that majority 68.33 percent of the dairy farmers were having joint family type fallowed by 31.66 percent were comes under the nuclear family type. Finely concluded that mostly joint type of family member was found in the research area. These finding similar to the (Kaur and Rathoure, 2014), Dayal et al., 2015. Verma et al.,(2013).

Family size

The Table 1 showed that majority 38.33 percent of the dairy farmers were having small family size ranging from 4 to 6 members followed by the medium size family i.e. (8.40-8.93) members and large (>8.93) family size which were 35.83 percent and 25.83 percent respectively. Finely concluded that mostly small size of family i.e. 4-6 members was found in the research area.

Land holding

Table 4.9 revealed that 84.17 percent of the respondents were in the category of marginal, 14.17 percent were in small, 1.67 percent were in semi medium, landless, medium and large category of landholding was not involving in the dairy farming practices in the research area. These finding similar to the (Kaur and Rathoure, 2014), Dayal et al., (2015) and Verma et al.,(2012).

Occupation

The Table-1 revealed that 83.33 percent of dairy farmers engaged in dairy farming, 11.67 percent of dairy farmers engaged in agriculture + dairy + service involved respectively in the study area. These finding similar to the Dayal et al., (2015). Verma et al., (2013).

Annual Income

Table 1 revealed that 54.17 percent of the dairy farmers were in the low category of annual income ranges Rs. >87472, 35.00 per cent were categorised in high annual income ranges from Rs > 95460 and 10.83 percent were categorised in medium annual income Rs (87472-95460) in the research area. Concluded that most of dairy farmers were low category of annual income ranges Rs. >87472 in the research area. These finding similar to the Verma et al.,(2013).

Training Received

The Table 1 revealed that 84.17 per cent of dairy farmers not receive training in scientific dairy farming practices; only 15.83 percent of dairy farmers receive training in scientific dairy farming practices in the study area

Caste

In Table 1 Study Showed that the pooled mean caste of the dairy farmers majority (58.33%) of the dairy farmers belonged to the Other back word caste fallowed by schedule caste which accounts 32.50 per cent and 9.16 per cent were general category respectively. These finding similar to the Dayal et al., 2015.

Religion

In Table 1 study revealed that the pooled mean of the dairy farmer's majority (100.00%) of the dairy farmers belonged to Hindu group fallowed by Muslim group which were found for 00.00 percent. Finely concluded that Hindu were involving dairy practice in the study area. These finding similar to the (Kaur and Rathoure, 2014)

Experience in Dairy Farming Practices

The table 1 showed that 45.00 percent of the dairy farmers were having low (<19.31years) experience in dairy farming followed by the category of high (>21.51 years) and medium (19.31-21.51 years) experience in dairy farming which were 35.00 percent and 20.00 percent respectively. The findings are logically justified as respondents develop skill through dairy farming practices in the research area. These finding similar to the Dayal et al., (2015) and dissimilar to Verma et al.,(2013).

Socio-economic Profile of Dairy Farmers

Table 1: Socio-economic profile of dairy farmers regarding scientific animal Husbandry practices in eastern plain zone of Uttar Pradesh.

Variable	Category	Frequency	Percentage
Age (in Year)	Young (up To 35)	3	2.50
Range (31-70)	Middle (36-50)	46	38.33
Mean (52.77)	Old (>50)	71	59.17
	Illiterate (0)	12	10.00
	Functionally illiterate (1)	5	4.17
	Primary (2)	26	21.67
Education	Middle (3)	31	25.83
	Secondary (4)	19	15.83
	Higher secondary (5)	14	11.67
	Graduate and (6)	13	10.83
Family type	Joint	38	31.66
	Nuclear	82	68.33
Family size	Small (<8.4)	46	38.33
Range (3-16)	Medium (8.40-8.93)	43	35.83
Mean (8.66)	Large (>8.93)	31	25.83
	Landless (0)	0	0.00
	Marginal (1)	101	84.17
Land holding	Small (2)	17	14.17
	Semi medium (3)	2	1.67
	Medium (4)	0	0.00
	Large (>4)	0	0.00
Herd size	Low (>2.9)	51	42.50
Range (1-10)	Medium (2.9-3.3)	57	47.50

Mean (3.06)	High (>3.3)	12	10.00
Occupation	Agriculture +Dairy farming	106	88.33
	Agriculture + Dairy farming + Others	14	11.67
Annual income	Low (>87472)	65	54.17
Range	Medium (87472-95460)	13	10.83
(30000-260000)	High (>95460)	42	35.00
Mean (91446.39)	Training received	19	15.83
Training received	Training not received	101	84.17
Caste	General	11	9.16
	OBC	70	58.33
	SC	39	32.50
	ST	0	0
Religion	Hindu	120	100.00
	Muslim	00	00.00
Experience	Low (<19.31)	54	45.00
	Medium (19.31-21.51)	24	20.00
	High (>21.51)	42	35.00

Conclusion

Majority (59.17%) of dairy farmer's belonged to old age group (>50 years), majority (25.83%) belonged to middle category, majority 58.33 per cent of the dairy farmers belonged to the other back word caste, majority 68.33 per cent of the dairy farmers were having nuclear family. majority (52.50%) of dairy farmers were in medium category of personal localite, information like family members, relatives, friends, Progressive farmers and others were used as source information in scientific dairy farming practices. Socioeconomic profiles like age, education, family size, family type and more social participation compression to other socioeconomic status have good scientific animal husbandry practices in research area. There is also need to develop problem oriented strategies in particular region to increase good scientific animal husbandry practices and strengthen the agricultural economy of the farmers.

Acknowledgements

The authors thank Dean, College of Veterinary Science and Animal Husbandry for providing necessary facilities.

Conflict of Interest: None

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Review Article

Journal of Animal Feed Science and Technology
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Enrollment of Rumen Microbiota in Utilization of the Dietary Lipids and Synthesis of Cis 9 Trans 11 Conjugated Linoleic Acid: A Review

Ram Kumar Singh[1], Mala Singh[2], Avijit Day[3]

How to cite this article:

Ram Kumar Singh, Mala Singh, Avijit Day/Enrollment of Rumen Microbiota in Utilization of the Dietary Lipids and Synthesis of Cis 9 Trans 11 Conjugated Linoleic Acid: A Review/ Journal of Animal Feed Science and Technology 2022;10(1):15–18.

Abstract

Utilization, extraction of energy and synthesis of various micronutrients through dietary lipids in ruminants is solely dependent upon rumen microbial efficacy. Rumen microbes are not only the pioneer of lipid digestion, but also the key factor to decide the physical & biochemical characteristics of input dietary lipids owing to the lipolysis and followed by biohydrogenation of dietary lipid through rumen microbes. Optimal microbial balance and proper scientific requirement of dietary lipids influences the digestibility and utilization of dietary lipids. Thus, aforesaid article developed to discuss key insight considerations of rumen microbes to utilizedietary lipidsin ruminants.

Keywords: Ruminants; Rumen microbes; Dietary lipids.

Introduction

Conventional ration for the lactation purpose rarely contain greater than 3.5% fat (ether extract). Moreover, this fraction represents up to 50% proportions from forages (green forages) and remaining 20% from grains (energy rich concentrates). In plant leaves, the major non-fatty acid lipid components are waxes, pigments (chlorophyll) etc. and other non-saponifiable material. Lipids from forages, mainly consist of glycolipids, galactolipidsand richer source oflinolenic acid (C18:3 n-3); other feed contain a whole range of fatty acids, from short and medium chain in coconut oil to fatty acidswith 20-22 carbons in fish oil. The main sources of nutraceutical fatty acid viv. Cis 9 trans 11 linolenic acid (CLA) supplementations are linseed, canola (mustard), soybeans, nuts and dark green forages. Omega-3 (ω3) fatty acids are mainly from animal origin and mainly found in cold water and salt water fishes viz. salmon, trout, mackerel and sardines. The main sources of linolenic acid (C18:2 n-6) are sunflower seed, safflower, soybean, nuts and sesame seed. γ-linolenic acid (C18:3 n-6) is found in evening primrose oil and grape seeds. Dihomogama-linolenic acid (C 20:3 n-6) is found in maternal milk while arachidonic acid (C20:4 n-6) occurs mainly in meat and animal products. Oleic acid (C18:1) is found in olive, almond, ground nut, cashew and butter (Sukhija and Palmquist, 1988).

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Received on: 19.03.2022 **Accepted on:** 01.04.2022

Digestion and Metabolism of Dietary fat in Ruminants

The utilization of fat by ruminants is characterized by serial events in the rumen before they are digestive and absorbed in the intestine. During their stay in the rumen, fat are biohydrogenated (Fig. 1) so that the amount and composition of fat leaving the rumen differs from that of its intake.

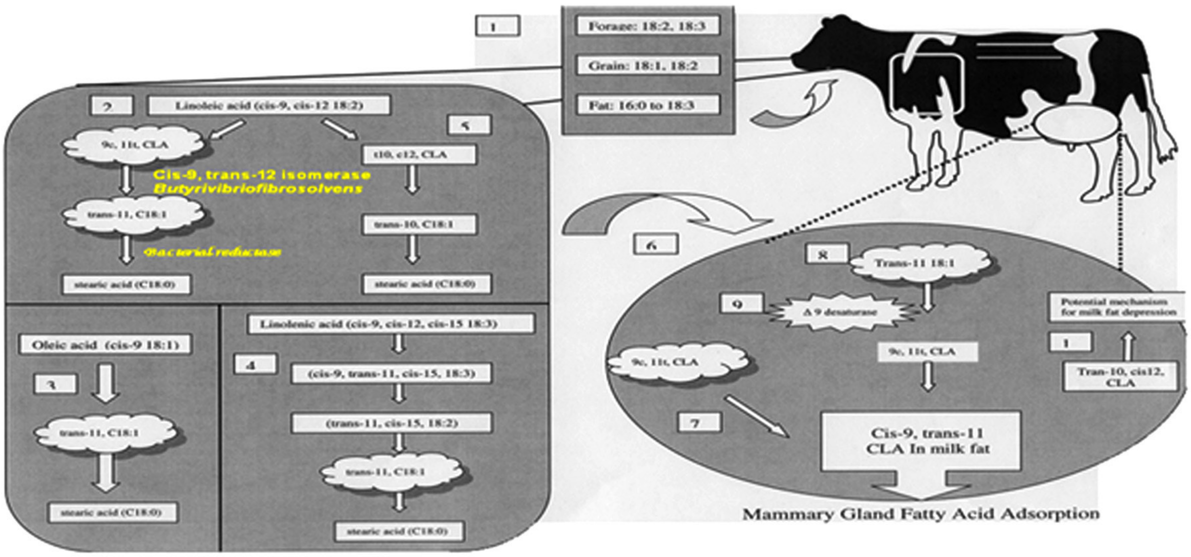

Fig. 1: Biohydrogenation pathway and fate of fatty acids in the rumen.

Lipolysis in Ruminants

Esterified plant lipids, shortly after consumption are hydrolysed extensively by microbial lipases causing the release of constituent fatty acid (Fig. 1; Fig. 2) Anaerovibriolipolytica, identified as the best known rumen bacteria for its lipase activity produces a cell bound esterase and a lipase (Harfoot, 1978). Fay et al. (1990) identified 74 strains of ruminal bacteria that were capable of hydrolyzing the ester bond in P-nitrophenylpalmitate. Known lipolytic microbial strains including Anaerovibriolipolytica and Butyrivibriofibrisolvens, had low hydrolysis in that assay. The ruminalprotozoal population (Harfoot and Hazelwood, 1988) also showed extensive lipolytic activity. Hydrolysis of galactolipids and phospholipids is attributed to a variety of galactosidases and phospholipases (including phospholipase A, phospholipase C, Iysophospholipase and phosphodiesterases) produced by ruminal microbes (Harfoot and Hazzelwood, 1988).

The lipase is an extra cellular enzyme present in membranous particles and composed of protein, lipid and nucleic acid. This lipase hydrolyzes the acylglycerols completely to free fatty acids (FFA) and glycerol with little accumulation of mono or diglycerides (Hawke and Silcock, 1970). Glycerol is fermented rapidly, yielding propionic acid as major end product.

The extent of hydrolysis is approximately 85-95% for most unprotected lipids (Bauchart et al., 1990). This proportion is higher for the diets richer in fats than for conventional diets in which the most lipids are components of cellular structure. Hydrolysis seems to be the highest for diets richer in protein (Gerson et al., 1983). Some factors have been found to decrease lipolysis viz. antimicrobial supplementations and low pH (VanNevel and Demeyer, 1995). This later factor explains why lipolysis is reduced with diet rich in starch (Gerson et al., 1985).

Esterified Plant Lipids

↓ Lipase, Galactosidases, Phospholipases

Unsaturated FFAs
(eg. *Cis*-9, *Cis*-12, $C_{18:2}$)

↓ Isomerases

Cis-9, *Trans*-11 $C_{18:2}$

↓ Reductase

Trans-11 $C_{18:1}$

↓ Reductase

$C_{18:0}$

Fig. 2: Key steps in conversion of esterified plant lipid to the saturated fatty acids by lipolysis and biohydrogenation in the ruminal contents.

Biohydrogenation of Lipids

The unsaturated free fatty acids have relatively shorter half life span in ruminal contents because they are rapidly hydrogenated by microbes to the more saturated end products. Hydrogenation generally takes place at a slower pace than lipolysis, but few PUFA are present in the rumen (Doreau and Chilliard, 1997). On contrary to the extensive debate, biohydrogenation contributessomewhat as a hydrogen sink, as only 1-2% of metabolic hydrogen is used for this purpose (Czerkawski and Clapperton, 1984).

The initial step of biohydrogenation is isomerization reaction that converts the cis-12 double bound in unsaturated fatty acids to a trans-11 isomer. The isomerase is not functional unless the fatty acid has a free carboxyl group and in the case of polyunsaturated fatty acids such as C18:2 a cis-9, cis-12 diene double bond configuration is present (Kepler et al., 1970). The requirement of free carboxyl group establishes lipolysis as a pre-requisite for biohydrogenation. Once, the trans-11 fatty acid bond is formed by the action of isomerase, their hydrogenation of cis-9 bond in C18:2 occur by a microbial reduction. Butyrivibriofibrisolvense and Ruminococusalbus species are among the important microbes responsible for biohydrogenation (Kemp et al., 1975). Harfoot and Hazelwood, (1988), investigated various pathways for the reduction of fatty acids by hydrogenases. The end product of hydrogenation of C:18 fatty acid is stearic acid. However, when large amounts of linolenic acid are available, hydrogenation generally stops before this final step, leading to the formation of various cisand trans isomers of monoenoic fatty acids (Harfoot, 1978). The most important is trans-vaccenic acid (C18:1 n-7). The extent to which dietary unsaturated fatty acids escape hydrogenation appears to depend on microbial growth conditions that influence rate of lipolysis and biohydrogenation. Grain feeding suppresses the ruminalbiohydrogenation and promotes increased unsaturation of the carcass fat and milk. This effect is attributed to decreased lipolysis resulting from lower ruminal pH (Latham et al., 1972; Kemp et al., 1991). Diminished rate of lipolysis and hydrogenation is caused by low dietary N2 supplementations (Gerson et al., 1983), small feed particle size (Gersonet al., 1988) and maturity of forages (Gerson et al., 1986).

Bacteria incorporate fatty acids and are also able to synthesize a wide variety of fatty acids, those with 15 and 17-C atoms being the more characteristic. Synthesis occurs mainly from volatile fatty acids, branched chain fatty acids arise from isoleucine and leucine (Doreau and Chilliard, 1997). Bacterial cisand trans monounsaturated fatty acids may result from desaturation of the saturated fatty acids. Linoleic acid can also be synthesized (Demeyer and Hoozee, 1984). The extent of this de-novo synthesis is lower than the extent of dietary fatty acids incorporation and decrease when the ruminal fatty acids concentration increases (Demeyer et al., 1978). Protozoa (Emmanuel, 1974) and rumen fungi (Kemp et al., 1984) can also incorporate and synthesize fatty acids. Synthesized and assimilated fatty acids are esterified as phospholipids as sterol esters, and constitute structural lipids. When large amounts of fatty acids are fed, they are stored as free fatty acids in cytosolic droplets (Bauchart et al., 1990). These droplets are especially richer in linoleic acid which thus escapes the biohydrogenation.

Conclusions

Traditional ration of ruminants, especially green fodder and concentrate mixture are the richer source of lipid. Liplysis followed by biohydrogenation of dietary lipid through rumen microbes fulfill the requirement animal body for various biosynthesis and energy generating mechanism. Microbial digestion of dietary lipids reshuffles the shape and configuration of dietary lipids. Thus, meeting of dietary lipid requirement and microbial balance enhances the utilization of dietary lipids in ruminants.

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STATEMENT ABOUT OWNERSHIP AND OTHER PARTICULARS

"Journal of Animal Feed Science and Technology" (See Rule 8)

1. Place of Publication	:	Delhi
2. Periodicity of Publication	:	Quarterly
3. Printer's Name	:	**Dinesh Kumar Kashyap**
Nationality	:	Indian
Address	:	3/259, Trilokpuri, Delhi-91
4. Publisher's Name	:	**Dinesh Kumar Kashyap**
Nationality	:	Indian
Address	:	3/259, Trilokpuri, Delhi-91
5 Editor's Name	:	**Dinesh Kumar Kashyap**
Nationality	:	Indian
Address	:	3/259, Trilokpuri, Delhi-91
6. Name & Address of Individuals who own the newspaper and particulars of shareholders holding more than one per cent of the total capital	:	**Red Flower Publication Pvt. Ltd.** 41/48, DSIDC, Pocket-II Mayur Vihar, Phase-1, Delhi-91

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Review Article

Journal of Animal Feed Science and Technology
Volume 10 Number 1, January - June 2022
DOI: http://dx.doi.org/10.21088/jafst.2321.1628.10122.3

Occurrence of Antibiotic Residues in Milk: Detection and Public Health Concerns

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How to cite this article:

Abhishek Sharma, Atul Kumar, Neelam Sharma/Occurrence of Antibiotic Residues in Milk: Detection and Public Health Concerns/ Journal of Animal Feed Science and Technology 2022;10(1):23–29.

Abstract

There is an increase in demand for food of animal origin, due to increasing global population. Therefore, livestock owners around the globe are trying to increase animal product output which ultimately leads to enormous production pressure on the livestock. To achieve such high production goals, animals should be disease free and physiologically fit. To ensure their healthy status, antibiotics are being used extensively in therapeutic & sub-therapeutic doses to enhance production, which ultimately lead to presence of antibiotic residues in the final animal products like milk, meat, eggs etc. If such contaminated products are consumed by humans for a longer period of time, it may subsequently lead to significant health and economic issues ranging from emergence of AMR to starter failure in dairy industry. Therefore, present review focuses on various aspects of antibiotic usage in animal husbandry practices, initiative taken to combat AMR, methods used for detection of antibiotics in milk and their impact on human health.

Keywords: Antibiotic residues; Animal products; Detection methods; Human health risks.

Introduction

Animal sourced foods such as milk, meat, eggs, fish, and honey are being consumed by people across globe. They are considered nutritious and essential for growth and development of human body. But their image of being nutritious and healthy products is now getting tarnished. This is due to occurrence of pathogenic microorganism, antibiotics, pesticides, mycotoxins, hormones, heavy metals etc. in animal feed and animal sourced foods especially from India.[1-9] Among various xenobiotic, antibiotics are more commonly reported in animal sourced foods. Antibiotics are the substances which are produced naturally by living organisms or synthetically in laboratory conditions, and are able to kill or inhibit the growth of other microorganisms. Antibiotics enters the human body directly or indirectly by using antibiotics as growth promoters, feed efficiency enhancers or for treatment of various infectious diseases in animals.[10] These are one of the most commonly used veterinary medicine in relation to animal feed production and around 80% of animals used in food production are treated with antibiotics. The current global average consumption of antibiotics per kg of animal produced is >100mg/kg. Present use of antimicrobials for animal production in India is 30 kg/km2 which is expected to grow 312% by

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Received on: 12.11.2021

Accepted on: 12.12.2021

2030.[11]

In 1940s, the growth promoter effect of antibiotics was discovered when it was observed that animals show improved growth after feeding on dried mycelia of Streptomyces auriofaciens. Use of antibiotics as growth promoter may improve feed efficiency by 17% in cattle, 10% in lambs, 15% in poultry & 15% in swine.[12] Certain antibiotics are also used as premixes (Premixes are the mixtures of one or more active ingredients of antibiotic compounds that are exclusively used for preparation of medicated veterinary feeds). Medicated veterinary feeds are fed to animals after being mixed with animal feed. Examples of such antibiotics in medicated feed include oxytetracycline @ 4.4%, amoxicillin & ampicillin @ 0.025% owing to their high antimicrobial property and ability to resist digestion by gastric juices.

Antibiotics are administered to animals through various routes like parenteral, oral or topical. The residues level of antibiotics in animal produce are highest in the animals which are treated via injectable routes in comparison to oral routes. These antibiotic residues eventually appear in animal produce such as milk, meat and eggs. After consumption by the consumers through contaminated animal sourced foods, these residues are responsible for causing adverse health effects in humans such as carcinogenicity (oxytetracycline, furazolidone), nephropathy (gentamycin), mutagenicity, hepatotoxicity, reproductive disorders, anaphylactic shock (penicillins) and even transfer of antibiotic resistant bacteria (ARB) or antibiotic resistant gene (ARG) to humans.[12-13] In current world scenario, antimicrobial resistance has been a concerning problem and challenging towards treatment of various diseases. Apart from health effects on consumers, antibiotic residues in milk may interfere with fermentation process resulting in starter failure. This then contributes to significant economic losses in the dairy industry.

In context of above mentioned facts, the present review focuses on antibiotics usage in animal husbandry practices, their impact on public health and methods used for detection of antibiotics residues in milk.

Material and methods

The information presented in this review was obtained from a literature search of free electronic databases such as Google Scholar, PubMed, and Science Direct with regard to publications on antibiotic residues in milk. The key words used were "antibiotic", "antibiotic residues", "antibiotic residues in milk", "antibiotic residues in feed", "antimicrobial drug residues in food", "antimicrobial residues", "antimicrobial drugs in animals", "drug residues in milk", "antimicrobial drug residues in milk". The exclusion criteria included incomplete publications (i.e. papers with abstract only) and papers published in non-indexed journals. The inclusion criteria included full length original research papers, review articles, short communications in indexed and peer–reviewed journals.

Reasons for occurrence of antibiotics residues in animal sourced foods and food safety regulations in India Since there is ever increasing demand for milk & meat products, therefore antimicrobials have been an irreplaceable part of animal health care sector worldwide. For production of better quality products, the primary focus is always on the quality of raw products. Therefore, the health and disease free status of producing animal is a must from economic as well as welfare point of view. Antibiotics have been one of the most common medicine used for treatment of wide variety of infections in both humans and animals. However, residues of these drugs when excreted from body of treated animals or secreted in animal produce, may directly or indirectly enters the food chain. Direct sources of antibiotics to animals include parenteral or oral administration of antibiotic drugs, fodder mixed with antibiotics to enhance feed efficiency, intramammary or intrauterine infusion. Indirect sources include contamination of animal derived feed with water during processing, storage and transmission.[14] The contamination of feed and crops can also occur from faecal recycling as the drug residues gets excreted in the faeces of treated animals and faecal matter of animals is commonly used fertilizer in fields.[15] The major reasons for occurrence of antibiotic residues in animal sourced foods could be: (i) failure to follow a proper withdrawal period which is specific for each antibiotic drug, (ii) extra label use of antibiotics, (iii) poor record keeping of dairy animals, and (iv) mixing of milk from treated animals with the milk from untreated animals.

Consumption of such products with a higher level of antibiotic residues for a prolonged period may impart serious health risk to consumers. In order to avoid serious public health complications arising from irrational use of antibiotic drugs in producer animals, the Food Safety & Standards Authority of India (FSSAI) have established the Maximum

Residual Limits (MRLs) for antibiotic residues in various food of animal origins (Table 1).[16] Food commodities found to be exceeding these limits are not legally permitted to be sold to consumers in Indian domestic market. Similarly, other food safety agencies across the world such as European commission, US FDA, Codex Alimentarius Commission etc. have also established tolerance limits for antibiotics and other residues in milk to safeguard human health.

To tackle the issue of antibiotic misuse and AMR in India, Government of India and many NGOs have come forward with many initiatives such as an Inter-sectoral coordination committee to regulate non-therapeutic use of antibiotics in food animals has been constituted under National Policy for containment of AMR. Schedule H1 has been implemented by CDSCO and there is blanket ban on over the counter sale of almost 25 antimicrobials including cephalosporin, carbapenems, anti TB drugs & newer fluoroquinolones etc. A road map to tackle global challenge of AMR from Indian perspective was formulated in Chennai Declaration. GARP (Global Antibiotic Resistance Partnership) involving India, Kenya, South Africa, Vietnam, China are among other actions taken in this regard.

Table 1: Tolerance limit of various Antibiotic drug residues in Bovine milk.

Name of Antibiotics	Tolerance limit (mg/kg)
Monensin	0.002
Sulphadimidine	0.025
Ampicillin, Cloxacillin, Salinomycicin, Tyvalosin Tartrate, Virginiamycin, Sulphadiazine, Sulphathiazole sodium, Trimethoprim, Sulphadiazine, Sulphanilamide	
Sulphaguanidine, Bacitracin, Apramycin,Cephapirine, Clopidol, Enrofloxacin, Ethopabate, Flavomycin, Sulphaquinoxaline	0.01
Streptomycin	0.02
Colistin	0.05
Ceftiofur	0.1
Lincomycin	0.15
Oxytetracycline/Tetracycline, Spectinomycin	0.1
Neomycin	1.5

Public Health Concern of Antibiotic Residues in Food of Animal Origin

Antibiotics, if consumed for a prolonged period of time even in sub-therapeutic or low doses, may cause variety of effects on exposed population. Most common direct effects are hypersensitivity reaction (penicillin), yellowing of teeth (tetracycline), aplastic anemia (chloramphenicol) and gastro-intestinal disturbances.[17] Acute toxicity of sulphonamides leads to renal dysfunction and blood dyscrasias, while chronic toxicity leads to conditions like hepatic necrosis, hypothrombinemia. Tetracycline toxicity can also cause hepatotoxicity & nephrotoxicity. Streptomycin causes ototoxicity.[18] Certain macrolides are hepatotoxic in nature.[19] One of the major concerns is transfer of antibiotic resistance to humans which can either be by transfer of antibiotic resistant bacteria (ARB) or Antibiotic resistant gene (ARG) to humans through food chain or livestock handlers.[20] AMR is possibly the single biggest threat facing the world in the area of infectious diseases. Although little is known about magnitude of this problem with animal husbandry practices as determinant. This may be due to rare screening ofherds by the farmers, limited testing by veterinary diagnostic labs, poor surveillance mechanisms in exclusive animal pathogens compared to zoonotic pathogens, lack of resources, cost involved in culture or sensitivity testing, lack of coordination for collection, culture & antimicrobial testing methods or may be due to perceived low priority. However, this serious issue should be viewed at the same level of priorities as climate change or terrorism.

Methods for Detection of Antibiotic Residues in Milk

A plethora of analytical methods have been devised to qualitatively and quantitatively detect occurrence of antibiotic residues in food of animal origin especially milk. The various confirmatory and screening methods can be broadly grouped into four main categories viz. (i) microbiological methods based on bacterial growth inhibition, (ii) Immunochemical techniques (ELISA), (iii) Chromatographic methods (HPLC), and (iv) Biosensors based techniques.

Confirmatory tests rely on primarily on liquid chromatography coupled with diode array detector (HPLC-DAD) or with mass spectrometry (LC-MS).[21] LC-MS, a type of quantitative assay requires instrument with high response value & high sensitivity (Table 2). LC-MS method can detect multiple analytes in a single run due to its high selectivity & can detect analyte as low as ng/L or ng/gm.[22-23] Various preparation methods such as solvent-phase extraction (SPE) series like Solid-phase Microextraction (SPME) and Molecularly Imprinted Dispersive solid-phase extraction (MIDSPE) & Solvent Extraction (SE) series like Pressurized liquid extraction (PLE), Accelerated solvent extraction (ASE), and Solid–Liquid extraction (SLE) are implemented before chromatographic analysis by HPLC. Another method which is quick, easy, cheap, effective, rugged & safe (QuEChERS) has been widely used due to its low solvent consumption & high recovery.[24] It is a green chemistry based approach wherein, minimum quantity of organic solvents are utilized for extraction of targeted analytes.

Screening methods on the other hand are a type of qualitative or semiquantitative microbiological assay which are based on the reaction between susceptible organism and targeted antibiotic. Their advantages over the quantitative assay are that these are reliable, cost effective & simple to perform.[25] The other semi quantitative immunoassays are ELISA, Fluoroimmunoassay (FIA) & Time resolved Fluoroimmunoassay (TRFIA), Fluorescence-polarization immunoassay (FPIA), Immunosensors & Biosensors.[25-26] A biosensor, as defined by IUPAC, is a self contained integrated device that is capable of providing specific quantitative or semi quantitative analytical information using a biological recognition element (biochemical receptor), which is retained in direct spatial contact with a transduction element. Biosensors are classified according to the physicochemical transduction elements in electrochemical, optical, mass sensitive and thermal sensors.

Table 2: Detection of antibiotic residues in milk using HPLC.

Compounds	Sample preparation	HPLC system	Recovery	LOD (μg/L)	LOQ (μg/L)	Reference
Oxytetracycline and amoxicillin	SPE	HPLC-DAD	88-98%	1.3-2.0	3.8-6.1	27
58 Antibiotics	LLE	LC−ESI−MS/MS (+)	*	0.06−13.6	*	28
5 Fluoroquinolones	SPE	LC−ESI−MS/MS (+)	*	0.2	0.5	29
23 antibiotics	LLE - SPE	LC−ESI−MS/MS (+)	22 -143%	*	*	30
36 Antibiotics	LLE	TLX−ESI−MS/MS using optimized turbulent flow (+)	60 -105%	0.3−25.0	1.0−75.0	31
6 β-lactam antibiotics	LLE	LC−ESI−MS/MS (+)	42 - 81%	0.4−10.0	1.0−25.0	32
5 Fluoroquinolones						
and 1 quinolone	LLE	LC−DAD−ESI− MS (+)	64 - 96%	2.4−30	8−110	33
21 antibiotics	LLE	LC−ESI−MS/MS (+)	67 - 128%	0.1−2.5	0.1−5	34
33 Antibiotics	SPE	LC−ESI−MS/MS (+) and (−)	*	0.01−3.70	*	35
38 Antibiotics	LLE - SPE	LC−ESI−MS/MS (+)	68- 118%	0.01−5	0.03−10	36
6 Antibiotics	QuEChERS	LC−ESI−MS/MS (+)	84 -116%	0.4−3	0.1−0.5	37
25 Antibiotics	modified LLE method	LC−ESI−MS/MS (+)	62 -108%	0.2−10	2.5−25	38
6 Cephalosporins	MISPE	LC−ESI−MS/MS (+)	15 - 100%			
± 6%	0.1−3.8	0.4−12.5	39			
61 Antibiotics	LLE-SPE	LC−ESI−MS/MS (+)	62- 119%			
± 10%	0.003−1.57	0.001−5.18	40			
16 Macrolides and metabolites						
	QuEChERS	LC−ESI−MS/MS (+)	62 - 115%	0.30−0.85	1.1−4.0	41
15 Antibiotics	SPE	CZE−Q-TOF−MS	76 - 106%			
± 13%	0.5−2.9	1.5−9.6	42			
20 Antibiotics	dSPE	LC−ESI−MS/MS (+)	70 - 97%			
± 10%	0.10−2.40	0.33−7.92	43			
4 Antibiotics	LLE	LC−ESI−MS/MS (+)	61 - 111%	0.1−0.5	1.0−5.0	44

* Not available

Conclusion

Since antibiotics play a major role in keeping the livestock sector free from diseases, their occurrence in the foods of animal origin is also a major public health hazard & one of the alarming situations due to rise in number on antimicrobial resistant microorganisms, which often becomes a challenging task to treat. Veterinarians can play a major role in controlling the emergence of antibiotic resistant bacteria by judiciously using antibiotics with broad spectrum action and shorter withdrawal time. Livestock owners should be made aware about the consumption of produce from animal which is under treatment or have been recently treated with antimicrobials. Since, it may not be practically feasible to nullify the use of antibiotics in animals as the pathogens are omnipresent but precautions should always be taken while administering such drugs to animals. The ban on over the counter sale of antibiotics to avoid irrational use by livestock owners, restricting use of drugs in sub-therapeutic doses, avoid mixing of antibiotics in feed as growth promoters are some of the strategies which can probably minimize the risks associated with antibiotic residues in foreseeable future. In advance clinical settings, it is advisable to initiate antibiotic treatment only after the laboratory report of antimicrobial sensitivity testing. Action plans need to be devised in order to control such conditions. We cannot control the evolutionary development of microorganisms which are turning resistant to antibiotics on their own but the least we can do is to avoid the indiscriminate use of antibiotics which is an enabling factor for them to develop resistance against these magic bullets. Newer and old revisited approaches can move us from the end of antibiotic era towards a new dawn of antibacterial agents.

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2. Periodicity of Publication	:	Quarterly
3. Printer's Name	:	**Dinesh Kumar Kashyap**
Nationality	:	Indian
Address	:	3/259, Trilokpuri, Delhi-91
4. Publisher's Name	:	**Dinesh Kumar Kashyap**
Nationality	:	Indian
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5 Editor's Name	:	**Dinesh Kumar Kashyap**
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