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Mathematical Modelling for Resource and Environmental System- Special reference to Quantity of A2 type Milk in relation with Number of Lactation in Indigenous Cows.

Dr. Vinay Pandit
Mathematics and Statistics Department
Lala Lajpatrai College

1.0 Abstract

Natural resource like A2 milk is cow's milk that contains only the A2 variant of beta-casein protein. In referring to A2 milk, we are talking only about the specific type of protein it contains, called beta casein, and nothing else (not fat or carbohydrates). According to the literature, more than 10,000 years ago, and before they were domesticated, cows produced only the A2 beta casein protein and not the A1 beta casein protein. However, some 8,000 years ago a natural single-gene mutation occurred in Holsteins, resulting in production of the A1 beta casein protein in this breed. This mutation in the beta casein gene led to 12 genetic variants, of which A1 and A2 are most common. The mutation was passed on to many other breeds, principally because Holsteins are used to genetically improve the production of other breeds. Slowly, the A1 beta casein variant became dominant in milk. While dairy herds in much of Asia, Africa, and part of Southern Europe remain naturally high in cows producing A2 milk, the A1 version of the protein is common among cattle in the Western world. A point of reference is that A2 milk products are made from dairy cows that produce only the A2 beta casein protein, whereas today's cow's milk contains both A2 and A1 beta casein proteins. The most common variants among Western cattle are A1, A2, and B. Thus, an attempt is made by the researcher to highlight the importance and production of A2 type milk of Indigenous cows through mathematical Modelling.

Key words: A1 and A2 Milk, Beta casein protein, Mathematical Modelling

2.0 Introduction

Milk from dairy cows has been regarded as nature's perfect food, providing an important source of nutrients including high quality proteins, carbohydrates and selected micronutrients. More than 95% of the cow milk proteins are constituted by caseins and whey proteins. Among the caseins, beta casein is the second most abundant protein and has excellent nutritional balance of amino acids. Different mutations in bovine beta casein gene have led to 12 genetic variants and out of these A1 and A2 are the most common. The A1 and A2 variants of beta casein differ at amino acid position 67 with histidine (CAT) in A1 and proline (CCT) in A2 milk as a result of single nucleotide difference. This polymorphism leads to a key conformational change in the secondary

structure of expressed β-casein protein. Gastrointestinal proteolytic digestion of A1 variant of β-casein (raw/processed milk) leads to generation of bioactive peptide, beta casomorphin 7 (BCM7). Infants may absorb BCM-7 due to an immature gastrointestinal tract whereas adults gather the biological activity locally on the intestinal brush boarder. In hydrolysed milk with variant A1 of beta-casein, BCM-7 level is 4-fold higher than in A2 milk. Initial studies on indigenous cow (Zebu type), buffalo and exotic cows (taurine type) have revealed that A1 allele is more frequent in exotic cattle while Indian native dairy cow and buffalo have only A2 allele, and hence are a source for safe milk. Recently, a relationship between disease risk and consumption of a specific bovine β-casein fraction with either A1 or A2 genetic variants has been identified. BCM7 is suggested to be associated as a risk factor for human health hazards as it can potentially affect numerous opioid receptors in the nervous, endocrine and immune system. It is also known to be an oxidant of low dietary lipoproteins (LDL) and oxidation of LDL is believed to be important in formation of arterial plaque. Epidemiological evidences claim that consumption of beta-casein A1 milk is associated as a risk factor for type-1 diabetes, coronary heart disease, arteriosclerosis, sudden infant death syndrome, autism, schizophrenia etc. A broad range of studies from American and European investigations has shown reduction in autistic and schizophrenic symptoms with decrease in A1 milk intake. Further, animal trials have also supported the linking of type-1 diabetes to milk exposure in general and A1 beta-casein in particular.

Populations, which consume milk containing high levels of β-casein A2 variant, have a lower incidence of cardiovascular disease and type-1 diabetes. The A1/A2 hypothesis is both intriguing and potentially very important for public health if it is proved correct. It should be taken seriously and deeper research is needed to verify the range and nature of BCM7 interactions with the human gastrointestinal tract and whole organism. This requires more of animal trials and generation of data on human subjects having the problems related to A1/A2 beta-casein milk consumption.

In general, milks from Guernsey, Jersey, Asian herds, human milk, and others (sheep, goat, donkeys, yaks, camel, buffalo, sheep, etc.) contain mostly A2 beta casein. Milks from Holstein Friesian contain mostly A1 beta casein. The Holstein breed (the most common dairy cow breed in Australia, Northern Europe, and the United States) carries A1 and A2 forms of beta caseins in approximately equal amounts. More than 50 percent of the Jersey breed carries the A2 beta casein variant, but with considerable variation among the herd, and more than 90 percent of the Guernsey breed carries the A2 beta casein variant.

A mathematical model is a mathematical description of a real-world phenomenon such as size of population, demand for the product, life expectancy of a person at birth, quantity of milk produced by some particular cattle etc. The purpose of the model is to understand the phenomenon and perhaps to make predictions about future behaviour.

Step 1

Given a real-life problem, the researcher claims that the first task(activity) is to formulate a mathematical model by identifying and naming the independent and dependent variables under certain assumptions. In this research, dependent variable defined was quantity of milk and dependent variable was number of lactation. The assumptions considered in defining dependent and independent variables simplify the phenomenon to make it mathematical tractable and viable. The researcher has used physical situations and mathematical skills to obtain equation that relate the variables. If there are no physical laws to guide, the researcher may need to collect data by conducting either experiments or survey or else from secondary source and examine the data in form of table, graphs etc, so as to derive at a discrete pattern. In the current research, an attempt is made by the researcher to collect the primary data in from of quantity of milk and No. of lactation among Gir cows.

Step 2

The second step in modelling is to apply the mathematics which the researcher knows to the model that is formulated in order to derive at a mathematical conclusion. Here the researcher has used mathematical concepts of curve fitting and Extreme points.

Step 3

The third step is to take these mathematical conclusions and interpret them as information about the original real-life phenomenon of quantity of milk given by gir cows in a particular lactation. This can be done by explanation and logical reasoning and prediction.

Step 4

The final step is to test our predictions by checking against new real file data. A good mathematical model simplifies reality enough to permit mathematical calculations but is accurate enough to provide valuable conclusion.

2.1 Process of Mathematical Modelling

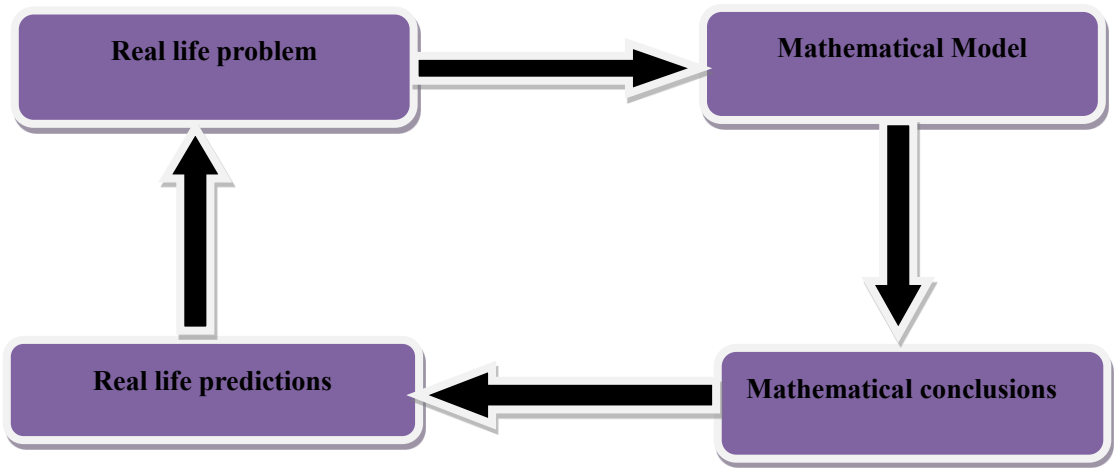

Fig. 2.1

3.0 Research Methodology

3.1 Purpose of Research

Th purpose of this research paper is to study the mathematical model in relation to quantity of milk produced with number of lactation in Gir cows. As the awareness regarding A1 and A2 type of milk is less, thus an attempt is made by the researcher to study the quantity of A2 type of milk produced in relation to the number of lactation among Gir cows.

3.2 Sampling Design

For the study undertaken systematic random sampling method with cluster sampling were used for the desired output. A sample of 20 Gir breeds cows were selected from different cowsheds.

3.3 Scope of Research

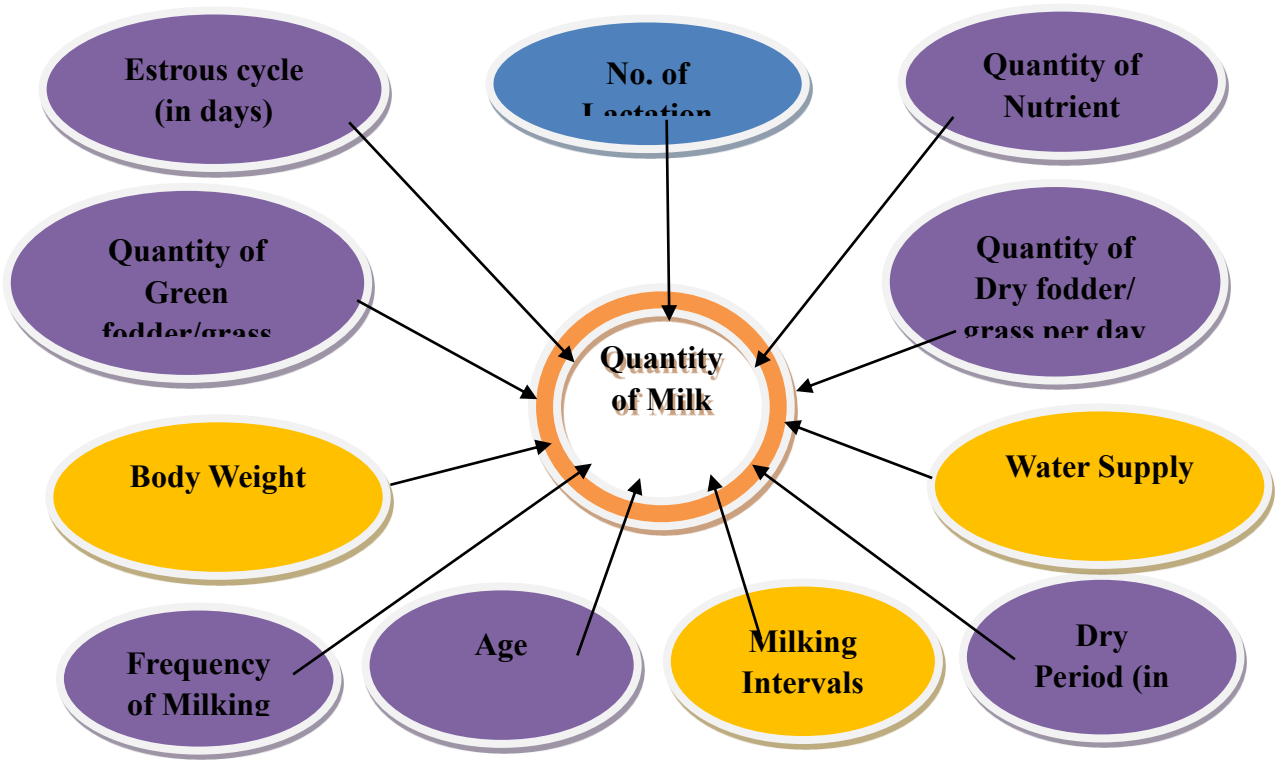

Fig 3.3

For the intention to focus on the current research, the scope of study was restricted to selected Gir Gaushala (Cowsheds) in the areas of Junagadh. Also, the experimental observations were limited to only 20 selected Gir breed cows and that too considering only one variable "Number of Lactation"

3.4 Research Design

The research design deployed was scientific experimental research design under controlled conditions. This research design includes experimental variables and controlled variables. However, there were many extraneous variables.

3.5 Mathematical Model

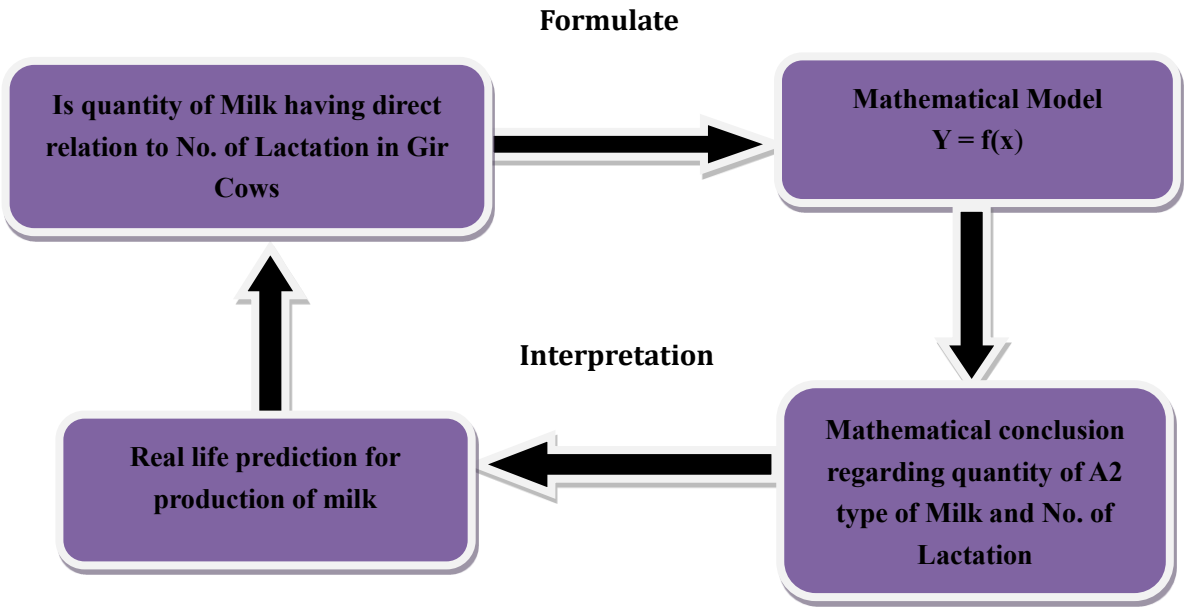

Fig 3.5

In the above model defined in Figure 3.5 Let Y = Quantity of Milk/day and Let X = No. of Lactation in Gir cow

3.6 Mathematical Technique

The mathematical technique used for the research is curve fitting using mycurvefit. Com, the online tool for building a model which can explain the relation between Quantity of Milk/day and Number of Lactation in Gir cow algebraically as well as geometrically. Also emathhelp.net was used to plot the entire curve and to calculate maximum and minimum amount of milk,

3.7 Method of Data Collection

The data collected for the purpose was secondary in nature through unstructured interviews from you tube and secondary experimental observations. Also, the secondary data was referred using research articles.

3.8 Limitations of Research

1) The study focuses on only two variables.
2) secondary data of only selected sample of cow was selected.
3) Curve fitting was done considering only cubic relation.
4) Only one independent variable namely "Number of Lactation" of Gir cow was considered.
5) One indigenous cow breed namely "Gir Cow breed" was considered.

4.0 Construction and Analysis of Model

The analysis of the data collected by the researcher was done by curve fitting using mycurvefit. Com, the online tool for building a model.

Table 4.0

Sr. No.	No. of Lactation (x)	Quantity of Milk / day (y)
1	1	11
2	2	12
3	3	10
4	4	13
5	5	15
6	6	12
7	7	15
8	7	13
9	7	15
10	8	16
11	8	18
12	8	16
13	9	17
14	9	18
15	9	20
16	10	18
17	10	20
18	10	22
19	12	20
20	12	25

Source: Secondary Data

The above data can be studied using the concept of curve fitting. The curve is approximated to be represented by cubic polynomial which is given by the below polynomial.

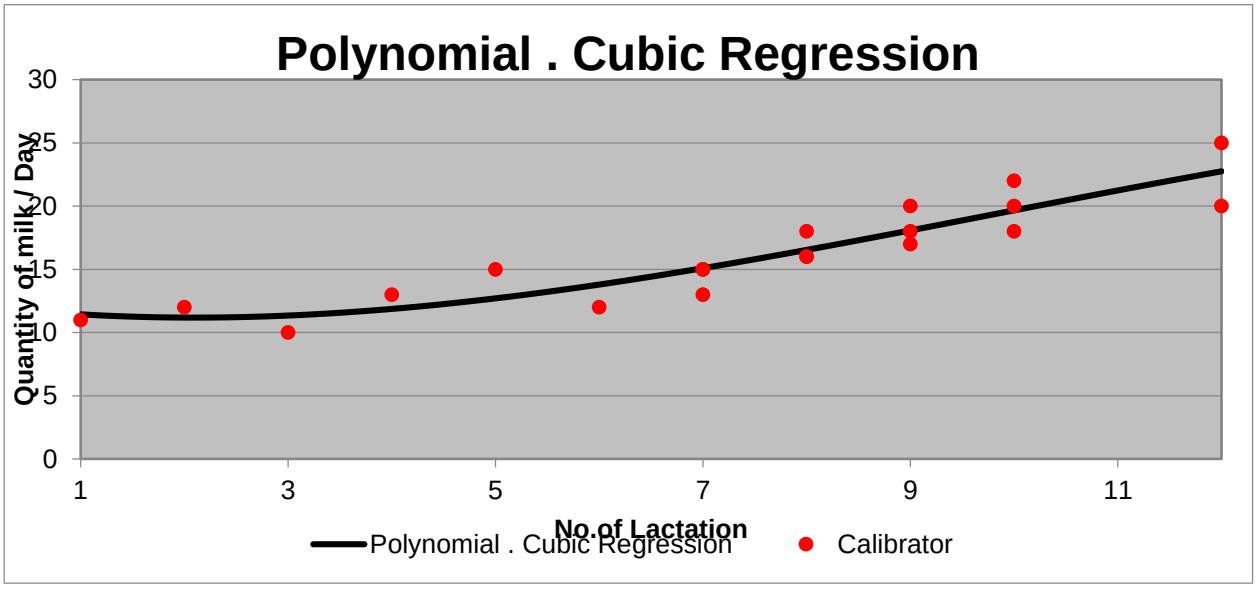

Fig 4.1

Let Y= f(x) be the function where x= **No. of Lactation** and y= **Quantity of Milk / day**

Let f (x) = $ax^3 + b x^2 + cx + d$ be the Approximate function. The researcher has used mycurvefit.com to plot the curve and hence derive a cubic polynomial which is given by

$Y= 12.168851 - 0.98198519x + 0.26232283x^2 – 0.0089118628x^3$

Table 4.1

Coeff.	Value	± Error
a	12.1688509383532	2.60441215218685
b	-0.981985191972178	1.5742567270978
c	0.262322834146928	0.26083963275094
d	-0.00891186276988834	0.01265843975923

Source: Mycurvefit.com

Table 4.2

Measure	Value
R^2	0.84363999274935
aR^2	0.814322491389854
P	0.000001106726898015
SE	1.68403670729253
F	28.7759854567576

Source: Mycurvefit.com

5.0 Findings

1)The researcher has used www.symbolab.com/solver to analyse **$Y= 12.168851 - 0.98198519x + 0.26232283x^2 – 0.0089118628x^3$**

2) The rate of change of quantity with respect to lactation period is dy/dx which is $-0.027x^2+0.52x-0.98$.

3) There were no global maxima or minima which justify that Gir breed cow do not have infinite milk production in relation to the lactation, but certainly has Local maxima in a certain finite interval.

4) The maximum quantity of A2 type of milk given by Gir cows is 28 litres which is during 17th Lactation.

5) The minimum quantity of A2 type of milk given is 11 litres which is during 2nd Lactation.

6) Also, the above cubic equation is significant in terms of quantity of milk produced in relation to the lactation period. This can be seen as p value is 0.000001106726898015 Which is less than 0.001.

7) The actual curve

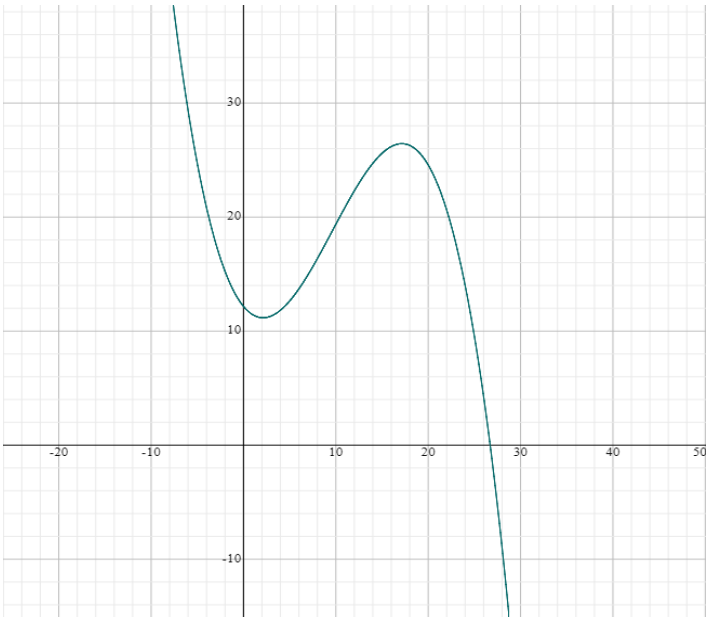

Fig 4.2

6.0 Conclusion

From the findings of the research, it may be concluded that the quantity of the milk produced is directly proportional to number of lactation among Gir cows. As the number of lactation increases the efficiency of milk production among Gir cows also increases. It is understood from finding that the minimum milk produced per day and the maximum milk produced per day is 11 litres and 28 litres per day respectively. From second lactation till seventeenth lactation the graph of milk produced show a steep increase in production in milk. Thus, a relationship between disease risk

and consumption of A1 genetic variants can be minimized if there is a transformation in awareness of A2 type of milk and its production importance in terms of natural resources. Since All cow's milk is part of a balanced diet, and a good source of many different nutrients. Milk containing predominantly A2 beta casein is as safe and wholesome as any other milk. Despite published studies evaluating the benefits of milk solely containing A2 proteins, no convincing evidence demonstrates its benefits over consumption of milk and dairy products containing a combination of A1 and A2 beta casein. But still the majority of science communities agree that there is a lack of evidence to prove A2 milk is better for health, and A2's beneficiary effects are anecdotal and not based on credible evidence. At last since India is rich in amount of natural resource like A2 milk which origins from Indigenous cows, there can be lot of scientific study which confirms the perseverance of these types of cows.

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