University of Zambia
School of Agricultural Sciences
Department of Animal Science

Quality of Milk Produced by Some Selected Small-Scale Farmers around Lusaka.

A Project Report Submitted to the School of Agricultural Sciences, University of Zambia in Partial Fulfilment of the Requirements for the Degree of

Bachelor of Agricultural Sciences

By

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Dedication

To my mother Chiluba, my brothers Bwalya, Lwamba,

Auto and above all to the memory of my late father

Shepherd Bwalya Makasa.

My late father has and will always

be the biggest influence on my life

besides God Almighty.

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Acknowledgements

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I should like particularly, to express sincere thanks to my supervisor Mr. K. Walubita for his assistance and encouragement. My other thanks go to the Parmalat staff and particularly Mr. Mweenga and Mr. Musonda of the Milk Quality Department. I also extend my thanks to the Secretary Ms. N.N. Hankolwe for typing this book. Finally but certainly not the least my thanks go to the Government of the Republic of Zambia for having financed my studies.

Abstract

The objective of this research was to establish whether small scale farmers produce milk of high quality or milk of low quality. And if they produce low quality milk establish the causes of this and make recommendations on how they can achieve high quality milk.

To achieve the objective the quality of milk produced by small scale farmers around Lusaka area was studied in relation to butterfat, solids not fat, percentage of water added to milk and the bacterial count in milk. This was done by studying records available at Parmalat of 27 small scale farmers for a period of 12 months i.e. from January 2002 to December 2002. The Percentages of Butterfat, solids not fat and water in the milk supplied by the 27 small scale farmers as well as bacterial count was compared with the minimum requirement of the Law in Zambia.

This study showed that milk composition was satisfactory i.e. was above the minimum requirement of the law, percentage of water added was 0.62 for the year 2002. Bacterial count was found to be of Grade B. This was particularly due to poor hygiene and lack of cooling facilities.

Introduction

General

According to regulation 154 of the Food and Drugs regulations of 1976, the Food and Drugs Act 22 of 1972 of the Laws of Zambia, milk or whole milk shall be the normal mammary secretion, free of colostrum and obtained from the mammary gland of the cow genus bos indicus and bos tauras and shall contain not less than 3% milk fat and 8.5% SNF (Solids not fat). The main constituents of milk are water, fat, proteins, lactose and minerals (Table 1).

Table 1: Showing the main Constituents of milk.

Main Constituents	Range (%)	Mean (%)
Water	85.5 – 89.5	87.0
Total solids	10.5 – 14.5	13.0
Fat	2.5 – 6.0	4
Proteins	2.9 – 5.0	3.4
Lactose	3.6 – 5.5	4.8
Minerals	0.6 – 0.9	0.8

Source: O' Connor, 1995.

Milk with the above composition and with low bacterial count, low content of foreign materials, low levels of detectable chemical residues and antibiotics and with a desirable flavour is referred to as good quality milk.

Good quality milk will improve the nutritional status of man in general, and infants and mothers in particular and transmission of diseases from animals to man would be – prevented or at least reduced , (O'Connor, 1995). Further more the knowledge of the quality of milk that is produced by small scale

man would be – prevented or at least reduced , (O'Connor, 1995). Further more the knowledge of the quality of milk that is produced by small scale farmers is of paramount importance for technical policies and the monitoring of performance of the nations dairy industry.

The data and information used in this text was collected from Parmalat a dairy company and from 27 small scale farmers around Lusaka. The percentages of Butterfat, solids not fat and water in the milk supplied by the 27 small scale farmers as well as bacterial count was compared to the minimum requirements of the Law in Zambia, to ascertain the quality of milk supplied by small scale farmers.

Problem Statement

Milk produced by small scale farmers is generally believed or thought to be of low quality. For the purpose of this study quality is defined in terms of freshness, adulteration, bacterial content and the percentages of the major milk components in the milk, i.e. it's nutritional status.

Justification

Depending on the quality of milk produced by small scale farmers they can or they can not:

1. Increase the chances of the spread of milk borne diseases such as Tuberculosis and Typhoid Fever.
2. Provide a complete food in milk in terms of nutrients.
3. Increase the size of their market, i.e. move milk processing organisations and individuals will be willing to buy their milk.

The justification for this study is that depending on the results of this study milk processing companies and households will be able to make informed decisions on the quality of milk produced by small scale farmers and the small scale farmers will know the quality of milk they are producing such that if there is need to improve they can do so,

Objective

The principal objective of this research was to establish whether small scale farmers produce milk of high quality or milk of low quality. And if they produce low quality milk establish the causes of this and make recommendations to small scale farmers on how they can achieve good or high milk quality.

Hypothesis

Small scale farmers produce high quality milk.

Literature Review

Milk Composition

In general the composition of milk gives an indication of the quality of milk. The principal components of milk are water, fat and solids not fat which include proteins, lactose, minerals, vitamins and several types of cells, that is, bacteria, leukocytes and mammary secretory cells (Bath et al, 1978). (Table 2).

Table 2: Gross Composition of Mixed Herd Milk

Constituent	Mean %	Range %
Water	87.2	82.4 – 90.7
Milk fat	3.7	2.5 – 6.0
SNF	9.1	6.8 – 11.6
Protein	3.5	2.7 – 4.8
Casein	2.8	2.3 – 4.
Lactalbumins & Lactoglobulins	0.7	0.4 – 0.8
Lactose	4.9	3.5 – 6.0
Minerals	0.7	0.6 – 0.8
Total Solids	**12.8**	**9.3 – 17.6**

Source: (Bath et al, 1978)

Milk Fat

Historically, milk fat has been the only component paid for directly and, therefore has been the only component that has been widely measured on individual cows, subjected to genetic analysis and included in genetic improved programmes (Bath et al 1978). The significance of lipids in milk and milk products could be economical, nutritional, flavour and physical properties. Fat could serve in pricing, a rich source of energy, a carrier of fat soluble vitamins – A, D, E and K; contain significant amount of essential fatty acids (linoleic and trachidonic) and aid in calcium absorption (Jenness and Patton, 1989; and Bath et al 1978). The desirable qualities of smooth body and texture, and rich mellow flavour of many dairy products are attributed to fat. Essentially all dairy products, except skin milk and those items made from skim milk contain varying amounts of fat. For example butter contains 80

percentage or more fat; cheese 30 – 40 percent fat and ice cream 10 – 18 percent fat (Bath et al, 1978).

Table 3: shows the composition of lipids in whole bovine milk.

Table 3: Composition of lipids in whole bovine milk.

	Weight %
Carotenoids + Vitamin A	Trace
Cholesterol esters	0.02
Triglycerides	98.3
Diglycerides	0.3
Monoglycerides	0.03
Free fatty acids	0.1
Cholesterol	0.20 – 0.40
Phospholipids	0.20 – 1.0

Source: O' Connor 1995

Milk Proteins

Proteins are essential to all forms of life as they perform a variety of functions, ranging from structure to reproduction, as well as immunity in living organisms. The nutritional or biological value of a given source of protein is measured in terms of the completeness with which it supplies essential amino acids (Bath et al, 1978). "Biological value" is defined as the percentage of digested and absorbed nitrogen (protein) that which is retained in the body for productive functions (Church, 1984). Milk has a high biological value, thus provides man with appreciable amounts of essential amino acids. Milk is hence a good source of high quality protein. The major component of milk

protein is Casein and also some α – Lactalbumin, β-lactoglobulin, and immune globulins (Acker, 1983 and Bath et al, 1978).

Casein constitutes about 80 percent of the total protein in milk and is unique in that it is found only in milk (Bath el al, 1978). In addition to amino acids, Casein also contain phosphorus and exists in milk as calcium caseinate. (Bath et al, 1978) further reported that Casein may be precipitated by acids or the enzyme rennin and rennin-precipitated Casein is the basis for curd formulation in cheese. Casein can also be used commercially for making glue, plastics, sizing of paper and paint adhesive.

The α -lactalbumin and β-lactoglobulin differs from casein in that they contain the sulphur bearing amino acid cysteine and the amino acid tryptophan rather than phosphorus (Bath et al, 1978). They also differ in that they are coagulated by heat easily and are not precipitated by acids. They however are nutritionally important in that they complement the qualities of casein. Immune globulins have a concentration of 0.1 percent of normal milk, (Bath et al, 1978). The concentration is greatly increased during the formation of colostrum, i.e. early lactation. Immune globulins act as an antibody carrier to protect the new born calf from pathogens.

Lactose in Milk

Lactose or milk sugar is the carbohydrate of milk and is in significant quantities, although traces of glucose and galactose could be found as well. Moreover, in most mixed milks, lactose was the solid constituent present in the greatest quantity. Lactose, differs from fat and protein in that it is found in true solution in milk, thus it affects the freezing point, boiling point and osmotic

pressure of milk (Jenness and Patton, 1989). Lactose is only one sixth as sweet as sucrose. The significancy of lactose in milk and milk products is that it controls fermentation in dairy products; contributes to the nutritive value of milk, it is related to texture and solubility of certain stored dairy products and is essential in the color and flavour of highly heated dairy products (Jenness and Patton, 1989).

The primary uses of lactose include, as an ingredient in infant foods and special dietary products; for the formulation and standardization of pharmaceuticals, tablets and pills and as a source of nutrients for antibiotic producing organisms (Jenness and Patton, 1989; and Bath et al, 1978).

The importance of lactose fermentation is basic in the dairy field. The manufacture of cultured milks and cheese, the processing of certain by-products, and the manufacture of lactic acid, the utilization of milk and milk products in the animals, the estimation of quality in milk and the differentiation and inhibition of certain micro-organisms all rest on the phenomenon of lactose fermentation (Bath et al, 1978 and Jenness and Patton, 1989).

Favourable human nutritional features of lactose include the ability to suppress protein putrefaction in the intestine and thereby impede growth of many pathogenic organisms (Bath et al 1978). The Lactic acid is also of considerable value after the administration of antibodies in that it assists in the re-establishment of desirable intestinal fluid. Further more, the low solubility of Lactose makes it less irritating than many other sugars, thus it is valuable in the treatment of stomach ulcer (Bath et al 1978, and Jenness and Patton, 1989).

Minerals and Vitamins of Milk

Mineral salts are important in nutrition especially as excellent sources of calcium and phosphorus the major minerals necessary for increased skeletal growth. The physical state and physical stability of the milk protein, particularly the caseinate is very dependent on the composition of the salt system (Jennes and Patton, 1989). Thus problems arising in heat coagulation of milk stem largely from variations in salt composition. Milk is, however, a poor source of iron and copper needed for haemoglobin (Wilson, 1992). However, iron could destroy some vitamins and even oxidise milk, causing a distinctive off-flavour (Bath et al, 1978).

Milk contains all known vitamins but it has been an especially good source of riboflavin (Schmidt and Van Vleck, 1974). However, it is distinctly inadequate in the amounts of Vitamin C and nicotinic acid that it could supply (Jenness and Patton, 1989). It is also a poor source of vitamin D although it could be increased, along with Vitamin A and E by supplying them in feed (Bath et al, 1978) or adding directly to processed milk.

Factors Affecting Milk Composition

The variations in the composition of milk is due to many factors, which can be physiological and environmental. Physiological factors are governed by both genetic and non hereditary factors such as age, number of previous lactations and pregnancy (Schmidt and Van Vleck, 1974). Milk fat and protein are the two major variable constituents. In milk constant composition is necessary for the manufacture of some products for example cheese (Jenness and Patton, 1989).

Stage of Lactation

During lactation, butterfat percentage fall as yield rise (Dalton, 1985). Thus there is a general inverse relationship between milk yield and protein and milk fat percentage (Schmidt and Van Vleck, 1974) lactose content show a very slight increase with advancing lactation or increase in yield (Schmidt and Van Vleck, 1974).

The first milk obtained after parturition colostrum, has a marked difference from normal milk, especially in protein content. Colostral milk has a very high percentage of protein due to the globulin content, particularly immuno globulins. These offer the new born passive immunity (Jeness and Patton, 1989). The milk fat and ash are also somewhat higher in colostral than normal milk. This increase in total milk solids may be related to the fact that the new born calf need a rich source of energy. Colostral milk is very rich in Vitamin A which serves to maintain the integrity of epithelial tissues thus aiding in the prevention of establishment of infections.

Health Status

Milk from quarters with mild clinical mastitis have decreased percentages of solids not fat (Schmidt and Van Vleck 1974). The most important factor affecting the level of lactose in milk is the condition of udder infection. Mastitis infection depress lactose although lactose is inversely proportional to ash content (Jenness and Patton, 1989). Mastitis, however, cause an increase in serum protein and chloride content of milk. The salty taste of mastitis milk is due to this increase in milk chloride content. The udder's ability to synthesize casein, lactose and fat is impaired by infection. Salts (Chlorides) of blood,

pass into the milk to correct the osmotic pressure deficiency caused by low lactose levels. The mammary gland tissue also became permeable to blood proteins due to changes in membrane permeability resulting from udder infection.

Metabolic diseases such as ketosis, milk fever and digestible upsets adversely affect milk production and may alter the composition of milk (Bath et al, 1978). A cow that is over conditioned at calving is more susceptible to metabolic disease, particularly ketosis due to the increased chance of imbalance between fatty acid metabolism and gluconeogenesis. Fat content of rations influence on milk is primarily a result of the energy value of the seed.

Milking Interval

After a long milking interval butterfat percentage tend to be low (Dalton, 1985). Dalton, further reported that three times daily milking compared with twice daily milking give a slightly lower fat percentage.

Temperature

Milk from tropical cattle contain definitely more fat and more ash than milk from temperate cattle; both these milks contain about the same proportion of protein and lactose (Williamson and Payne, 1987). High or low temperature depress milk production (Bath et al, 1978) thus an increase in milk composition.

The fat content is higher in summer than in winter this is due to environmental temperature (Jenness and Patton, 1989). Marked seasonal variations occurs in the levels of vitamins A and B due to seasonal availability of green pastures and sunlight. (Schmidt and Van Vleck, 1974).

Age

A high proportion of old cows in the herd would tend to lower the butter fat in the bulk sample, as the percentage of milk fat generally decline with age, (Dalton, 1985).

Pregnancy

Oestrus may temporarily depress milk yield and pregnancy reduce milk production during concurrent lactation (Bath et al, 1978) thus increase milk solid composition.

Stripping

The last drawn milk or strippings are much more richer in milk fat than the first drawn milk (Dalton, 1985), failure to strip the cows properly or if stripping is not done separately after milking machines are taken off, leads to milk without a uniform composition. The udder must be effectively stripped if the highest percentage of milk fat possible is desired in the milk. Milk secretion rate of the cow and milking practices would have an affect on milk composition (Bath et al, 1978).

Handling and Processing

Dairy farming has become a business and the business does not stop at the farm gate. For a successful dairy operation the dairy man should ensure high milk production per cow as well as high quality so as to find a market and a long-term demand for the milk by the consumers. Without proper handling and processing milk yield and quality would be adversely affected since milk is a perishable product.

The production of quality milk demand proper handling as from the cow to the consumer. Temperature and hygiene are the two important components in ensuring quality milk between milking and chilling and these seriously determine the potential of fluid milk production (Wilson, 1992). From the point of view of the consumer milk "quality" signifies or means three main characteristics of milk which determine suitability for human consumption and these are:

(a) Its cleanliness and keeping quality (milk should keep sweet for 72 hours at 15°C);

(b) Its freedom from pathogenic infection (such as tuberculosis); and

(c) Its nutritional valve based on its content of fat and other milk solids (Dalton, 1985).

Milk should be produced in a clean environment using clean equipment, must be cooled, processed and distributed to consumers in a rather short time. Sanitation is of primary importance in milk facilities. Cooling arrests rapid multiplication of bacterial and souring of milk (Acker, 1983) which otherwise would result in milk deterioration.

Micro-organisms in Milk

Micro-organism is the term applied to all microscopic living organisms. The micro-organisms principally encountered in the dairy industry include bacteria, yeast, moulds and viruses. Some microbes are harmfu,l for example, spoilage organisms and pathogens such as Salmonella while others are beneficial, i.e. lactic acid producing bacteria which cause milk to sour naturally. On average aseptically drawn milk from health udders contains between 500 and 1000 bacteria/ml. (O'Connor, 1995).

Dairy Hygiene

Milk is an excellent medium for the multiplication of bacteria of many kinds and the warmer the milk, the more rapidly will bacteria multiply (Barrett and Larkin, 1979). These two factors make milk produced in the tropics particularly vulnerable to heavy bacterial contamination between leaving the cow and being consumed. Contamination of milk can be brought about through:

(i) Dirty milker's hands

(ii) Dusty milking environments

(iii) Cattle dung on the udder and teats

(iv) Rodents, insects and birds

(v) Human carriers of clinical disease (for example sore throat and tuberculosis)

(vi) Water used for washing the udder, milking utensils and equipment.

Materials and Methods

The data and information used in this study was collected from Parmalat a dairy company. A total of 27 small scale farmers that supply milk to Parmalat had their daily milk supply for 2002 records, checked for milk freshness, adulteration, bacterial content and the percentages of the major milk components in the milk so as to determine the quality of milk supplied by the small scale farmers.

Personal visit were made to 8 of the 27 small scale farmers and observations were made especially on the following:

- Breed
- Nutrition
- Pastures
- Milking practices
- Health
- Handling of milk
- Cleanliness of milking parlours

All the 27 farms could not be visited due to several constraints that included time and financial capacity among others.

For each of the 27 farmers the monthly averages of milk fat (BF) solids not fat (SNF), bacterial count and percentage of added water were obtained from daily milk supply and were plotted on graphs to show the trends for a period of 12 months. Two graphs were produced for each farmer one showing the

percentage of added water, Butter Fat (BF) and solids not fat (SNF) and another one showing the bacterial count from January 2002 to December 2002. The graphs for all the 27 farmers are included in the appendix.

Then the monthly averages of milk fat (BF), solids not fat (SNF), percentage of added water for all the 27 farmers were obtained and plotted as shown on Graph 1. The monthly averages of bacterial count for all the 27 farmers were also obtained and plotted as shown on Graph 2.

Finally for all the farmers the yearly averages of BF, SNF, percentage of water added and bacterial count were determined (table 4. The values were compared with standards set in the Laws of Zambia, i.e. milk fat should not be less than 3% and solids not fat 8.5%, percentage of added water 0 percent and in terms of bacterial count, Milk is graded into three categories which are:

A Grade (0 to 50,000 bacteria per ml of milk

B Grade (50,001 to 200,000 bacteria per ml of milk

C Grade (greater than 200,000)

Source: regulation 154 of the Food and Drugs of 1976.

Results and Discussion

Freshness of milk

The production of acid in milk is normally termed souring and the sour taste of such milk is due to lactic acid. The percentage of acid present in milk is a rough indication of it is age and the manner in which it has been handled (O'Connor, 1995). Several methods are available for determining the amount

of lactic acid and this include among others, Titratable acidity test, in which either N/10 sodium hydroxide or N/9 sodium hydroxide are used and the alcohol test.

This is a criteria that is used for accepting or rejecting milk by Parmalat (depending on whether the milk is fresh or sour). Fresh milk should contain 0.15% or less lactic acid. For the year 2002 none of the 27 small scale farmers had their milk rejected by Parmalat. This means that the small scale farmers produced and delivered fresh milk to Parmalat. However, some small scale farmers did not manage to supply milk everyday during the year 2002. But when they supplied it was fresh milk.

Milk Fat and Solids not Fat

The yearly average values for all the 27 farmers in terms of BF = 3.7 and SNF = 9.22 (table 4) and are both above the minimum standards set by the laws of Zambia. The small scale farmers were able to achieve this due to good management of the livestock enterprise with respect to nutrition and health of animals which are the two most important factors in determining the percentages of BF and SNF in addition to genetic factors i.e. breed.

Nutrition: Milk synthesis can be divided into lactose,protein and fat synthesis. The primary precursor in lactose synthesis is glucose which has to taken up from the blood. The source of blood glucose in ruminants are volatile fatty acids (VFA), acetate, propionate and butyrate. In the cow, the main source of glucose is propionate, milk protein is synthesised using amino acids while the primary blood precursors of the fatty acids in milk in ruminants

is acetate and β-hydroxybutyrate. The 8 farmers that were visited provided supplementary feed to the animals during the dry season when natural feed, i.e. grass is low in quantity and quality. They provided hay and formulated concentrates. The main ingredients that were used on most farms included:

1. Sunflower cake for proteins
2. Maize bran, energy
3. Salt (Nacl) mineral supply
4. Dicalcium phosphate DCP, mineral supply.

In almost all the 8 farms the feed mixing was done in such a way as to provide 12 - 14% cp for the dairy animals. 1 kg of concentrate was given for every 2 litres of milk produced by a cow.

This system of nutrition management lead to adequate supply of the primary precursors of BF, SNF.

Animal Health

Udder infections greatly influence the composition of milk. The principal effects of udder infections include:

1. lowering of the concentration of SNF
2. increasing the serum protein and chloride content of milk. (The salty taste of mastitis milk is due to this increase in the milk chloride content.) The udders ability to synthesize casein, Lactose and fat is impaired by Mastitis (O'Connor 1995). During the time the 8 farms were visited there were low cases of mastitis. All the animals that were suspected of mastitis were milked last and their milk tested for mastitis

using the strip-cup. On average 3 animals had the infection at any one point in time.

Percentage of added Water and Bacterial Count

The percentage of added water had a yearly average of 0.62% (table 4) and from the Graph 1 the trend of water added was highest during the dry season. During the dry season when grass is low in quantity and poor in quality milk yield is generally low and farmers attempt to increase the yield by adding small quantities of water. However, 0.62% added water is a very minimal degree of adulteration and hence of no significance in as far as milk quality is concerned. The accepted average percentage of water in milk is 87.2, however, small scale farmers used in this study had a yearly average of 87.82% (table 4.)

Bacterial Count

The average bacterial count for the year 2002 for all the farmers was 121,163 (table 4). This means that the average grade was B. The highest bacteria count was recorded in September, October and November and were 166,684, 162,400 and 156,000 respectively. The minimum were in May and June and were 85,000 and 83,565 respectively, (table 4).

Micro-organisms find their way into milk by two ways (1) Endogenous transmission which involve bacteria which are secreted into milk (2) Exogenous which is transmission into milk by way of contamination and of this two means the later was the most significant means by which bacteria found it's way into milk. This was attributed to the fact that small scale farmers

maintained their animals in perfect health. Disease control and prevention methods were strongly adhered to by small scale farmers around Lusaka i.e. they vaccinated their animals against common diseases such as Tuberculosis and Brucellosis. In addition Parmalat has a policy that farmers produce a certificate of vaccination against TB every 6 months.

The small scale farmers observed hygiene in a manner that can be described as moderate thus their moderate average class for bacteria count, i.e. Class B. The following were the observations made with respect to hygiene.

Milking Practices

The milking practices for all the farms visited were by hand milking and on average hand milking method required 5 minutes to milk a cow. The number of times of milking per day was two, one in the morning (05.00 hours) and the other in the afternoon (16.00 hours). During milking it was observed that the milking parlours were not always maintained clean, there was dust especially from the feed and the surrounding areas, in some cases the dung was not properly removed from the milking parlour except only when supervisors were present. Efforts to control rodents and insects were .completely absent. The water that was used for washing the udder, milking utensils and equipment remained most of the times exposed to bacteria contamination. In addition sometimes the milk remained in open buckets for some time before it was put in closed containers this exposed the milk to bacterial contamination. At some farms dung pits were too close to the milking parlour and were not emptied in time. This attracted too many flies to the milking parlour, thereby,

increasing the rate of milk contamination. The other major and important aspect that contributed to the observed bacterial count was the lack of cooling facilities. Six of the eight visited farms had no cooling facilities. Proper cooling and storage of milk requires facilities that will allow milk to be cooled down soon after milking in order to either slow bacterial growth (less than 15°C) or arrest bacterial growth (less than 5°C). However, some of the small scale farmers visited lacked this cooling facilities and instead depended on rapid transportation of milk to Parmalat and the informal markets. The milk milked in the afternoon mostly went sour and was sold at informal markets as sour milk

Graph 2 which is the bacterial count graph showed a trend indicating a high rate in the dry hot season and a low rate in the dry cool season. This can be attributed to temperature since high temperatures lead to increased bacterial multiplication. However, there is a positive correlation between the percentage of added water and the bacterial count of 0.3353 (table 4). This means that the increased bacterial count in the hot season can be related to milk adulteration. This study has revealed that milk contained added water of yearly average of 0.62% and that the incidence of water addition was highest during the dry hot season. This is a source of the observed increase in bacterial count around this time of the year.

Conclusions and Recommendations

The objective of this study was to investigate the quality of milk produced by small scale farmers around Lusaka. Quality was defined in terms of

nutritional status (i.e. composition of the milk), freshness, adulteration and bacterial count.

Composition of Milk

The composition of milk was studied in relation to Butterfat and Solids non fat. It was found out that milk composition was satisfactory as the monthly averages for all the 27 farmers studied were above the minimum required by the Laws of Zambia and, therefore, satisfied the nutritional requirements of milk.

Freshness

Milk is considered fresh if it contains 0.15% or less lactic acid. This study showed that milk marketed fresh by small scale farmers is indeed fresh milk as shown by the fact that none of the 27 farmers supplied non-fresh milk to Parmalat for the year 2002. This has been concluded on the basis that Parmalat did not reject on a single day milk supplied by any one of the 27 farmers.

Adulteration

Milk is said to be adulterated if it's ingredients have been tampered with accidentally or intentionally. This study has shown that the percentage of added water was 0.62 for the year 2002 for the 27 farmers studied.

Bacterial Count

The bacterial count for all the 27 small scale farmers for the year 2002 was found to be 121,163 which means that the 27 farmers supplied milk of B class

or category in 2002. Maximum bacterial count was recorded in the dry hot season and minimum in the dry cool season.

Recommendations

The major short fall with respect to the quality of milk supplied by small-scale farmers was the rate of bacterial count which averaged at 121,163 for the year 2002. While the value 121,163 is not in the worst class it would still be beneficial to improve and probably be able to supply milk of A Class in terms of bacterial count. The following points would provide some direction in trying to improve milk quality with respect to bacterial count.

(i) Keeping the milking parlour clean and free of rodents, insects and birds

(ii) Providing clean, preferably chlorinated water for washing the udder and milking equipment.

(iii) Maintaining a high standard of personal hygiene among the personnel involved in handling of milk.

(iv) Carrying out routine medical check ups among the personnel involved in the handling of milk.

(v) Educating personnel involved in the handing of milk of the need and importance of maintaining a high standard of hygiene throughout the handing of milk.

(vi) Provision of improved cooling facilities to farmers, this can be done even through the provision of loans as an incentive to encourage the dairy industry but this loans should not have very high interest rate charges. If cooling facilities can not be provided then, probably

wrapping of milk cans with wet cloth would help in reducing temperatures.

(vii) Small scale farmers should be able to transport their milk rapidly to the markets through reliable transport system i.e. good roads and vehicles.

Table 4

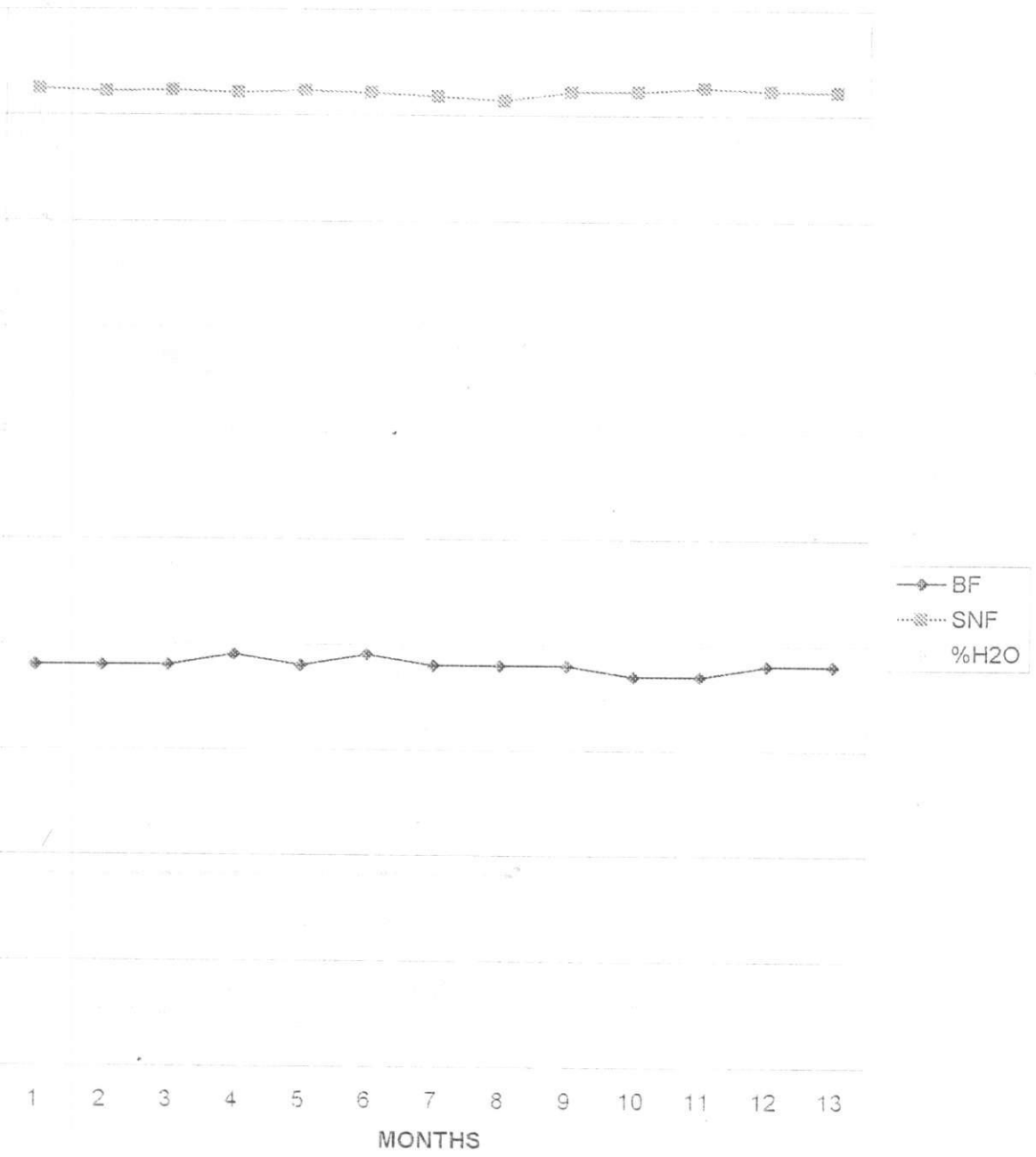
	BF	SNF	% + WATER	BC
January Average	3.7	9.24	0.38	106,278
February Average	3.7	9.23	0.48	108,031
March Average	3.7	9.22	0.49	126,661
April Average	3.7	9.23	0.43	100,087
May Average	3.7	9.22	0.49	85,000
June Average	3.7	9.23	0.43	83,565
July Average	3.7	9.23	0.45	111,739
August Average	3.7	9.23	0.45	131,952
September Average	3.7	9.23	0.46	166,684
October Average	3.7	9.23	0.48	162,400
November Average	3.7	9.23	0.48	156,000
December Average	3.7	9.23	0.47	115,556
Grand Average	3.7	9.22	0.62	121,163

CORRELATION

	BF	SNF	% + WATER	BC
BF	1			
SNF	0.424427	1		
% + WATER	-0.55657	-0.9787	1	
BC	0.176579	-0.31293	0.33530691	1

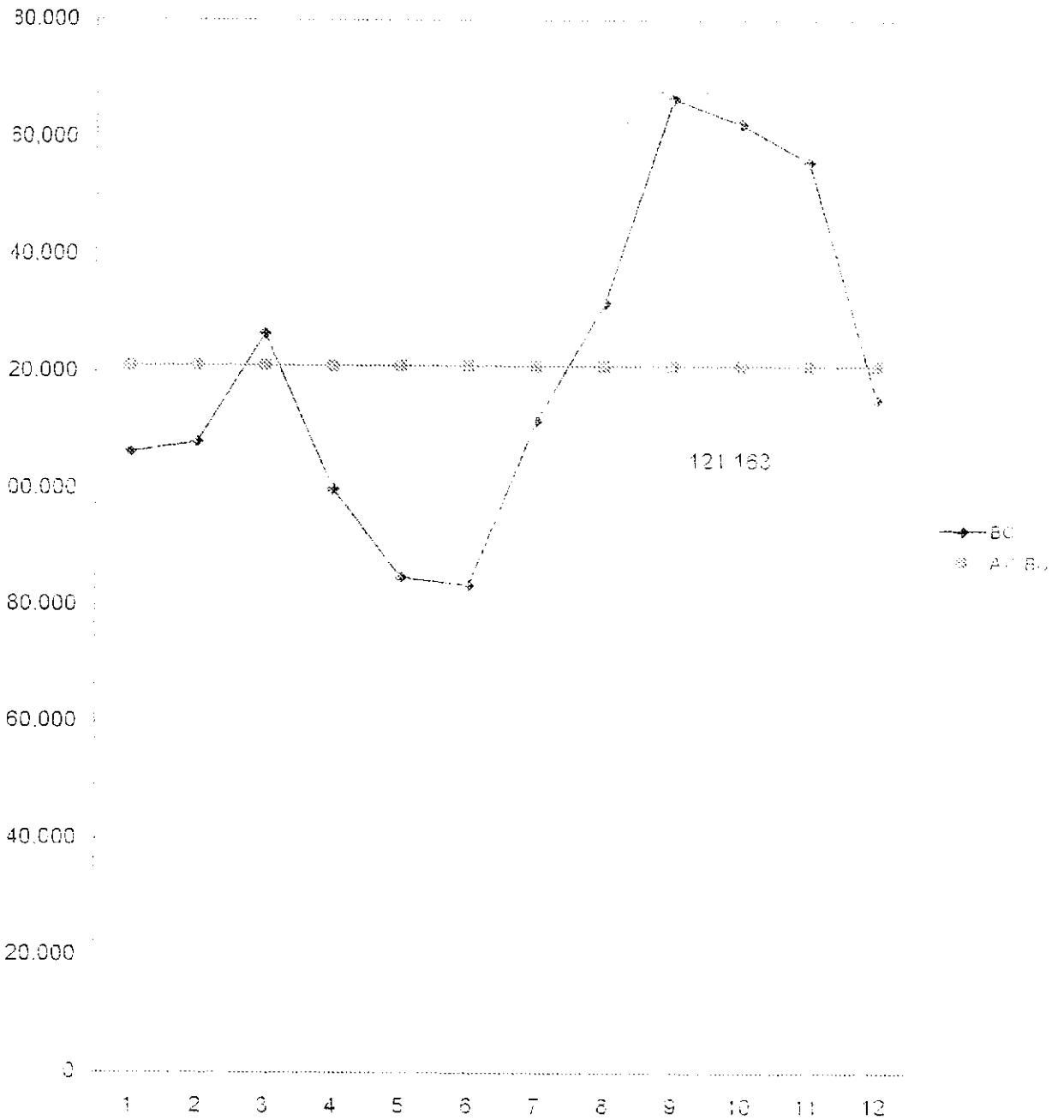
Graph 1

ALL FARMERS PAR



Graph 2

Bacterial Count for All Farmers



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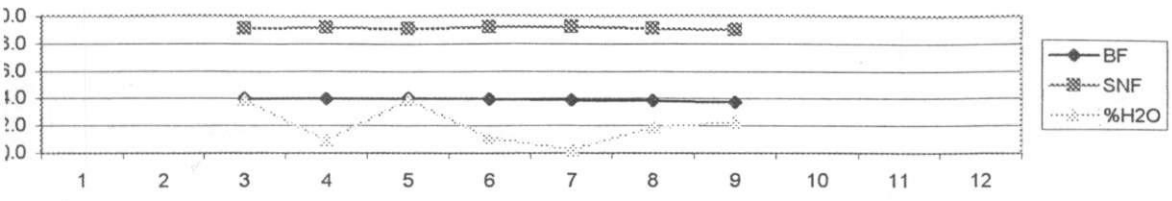
APPENDIX 1

PAR001



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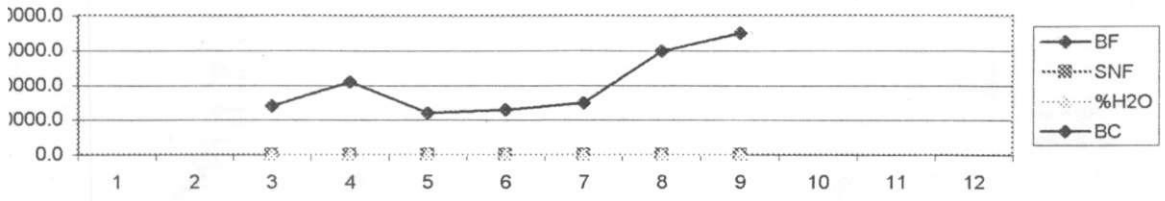

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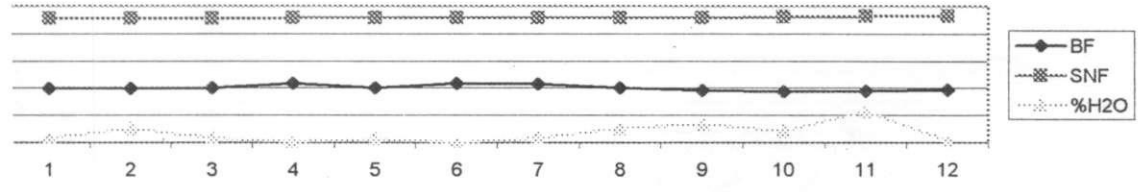

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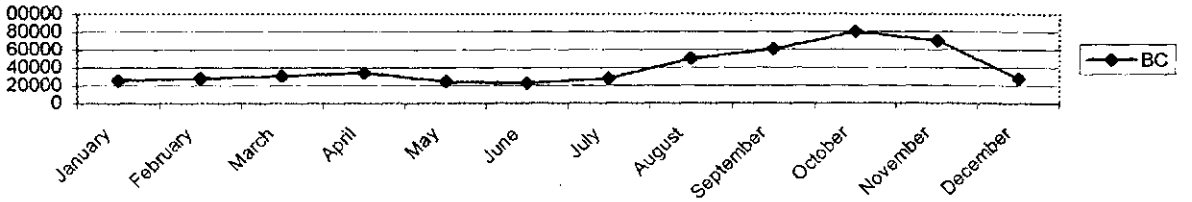

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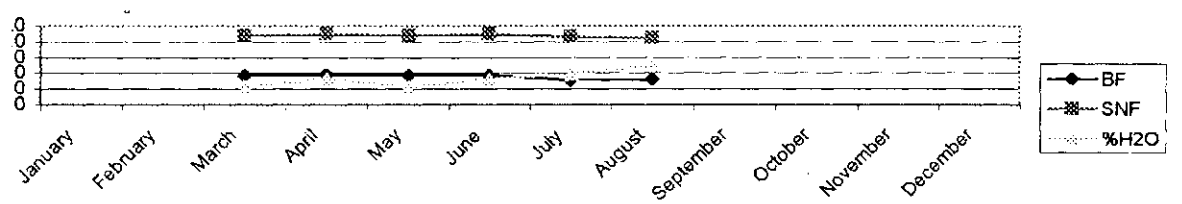

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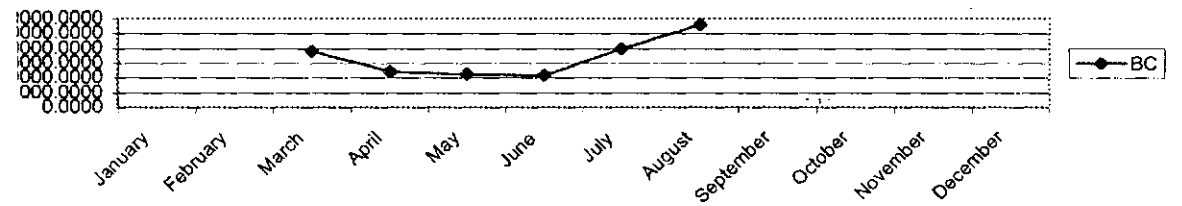

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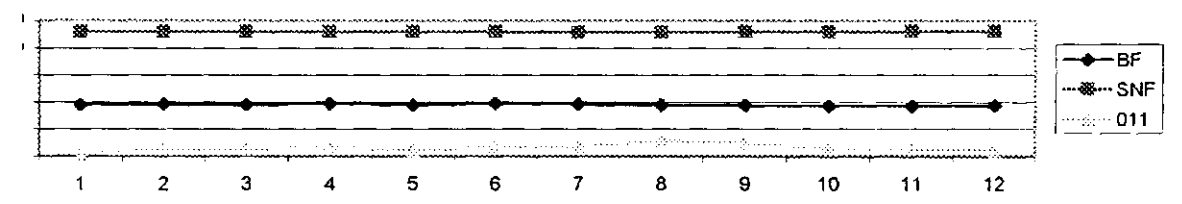

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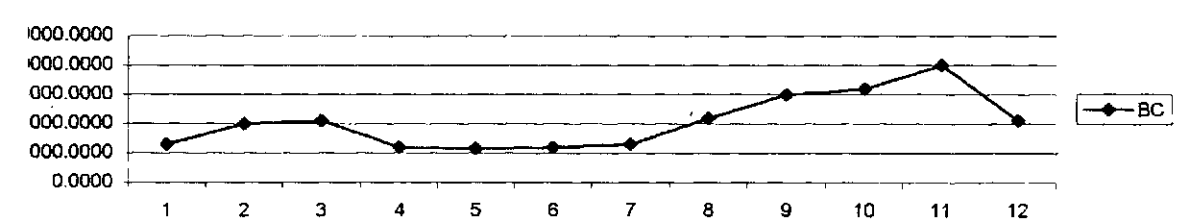

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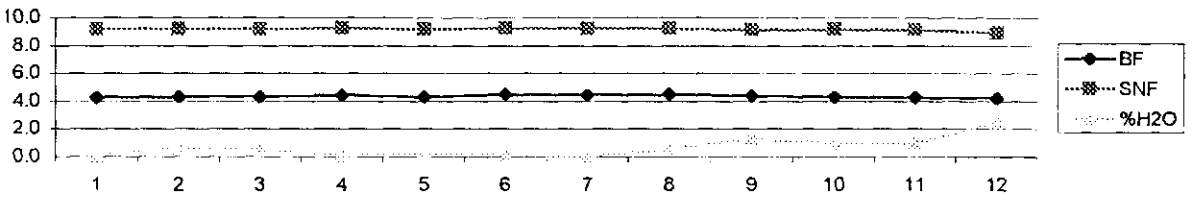

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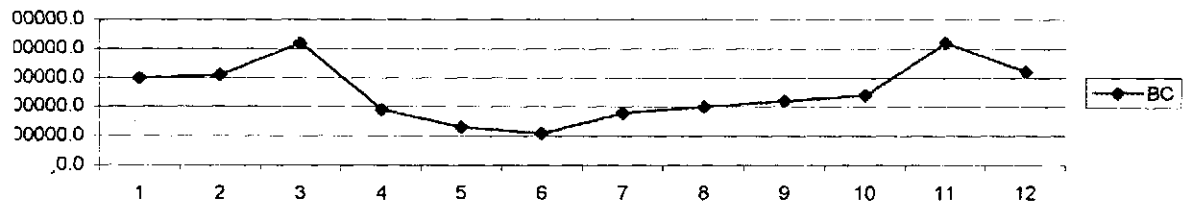

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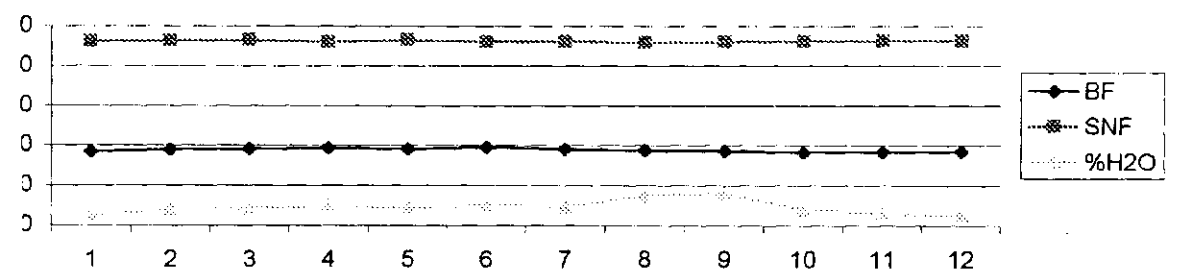

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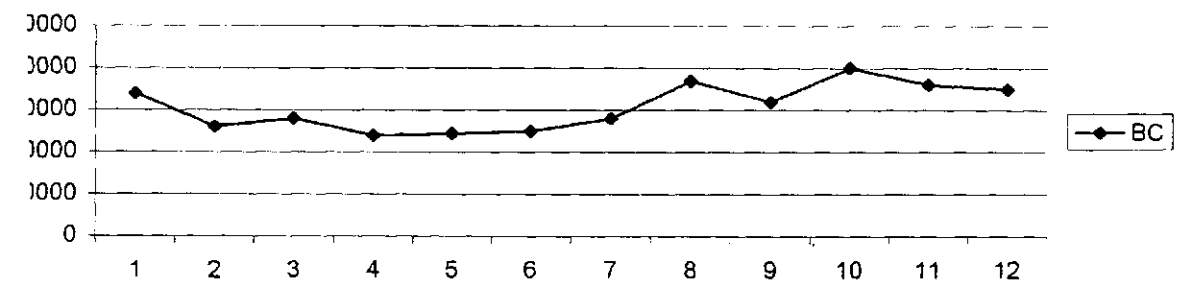

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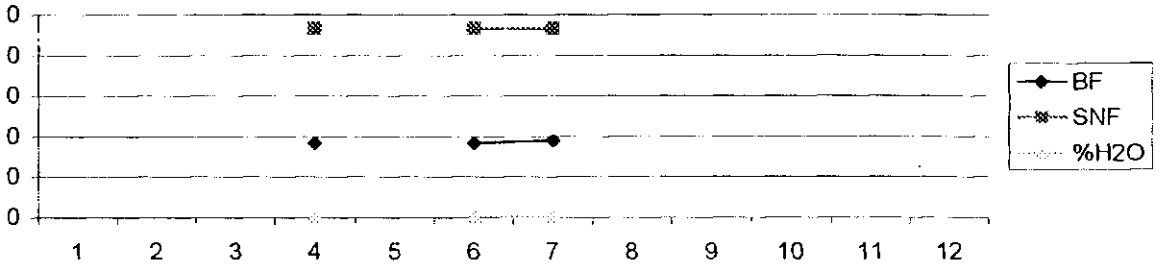

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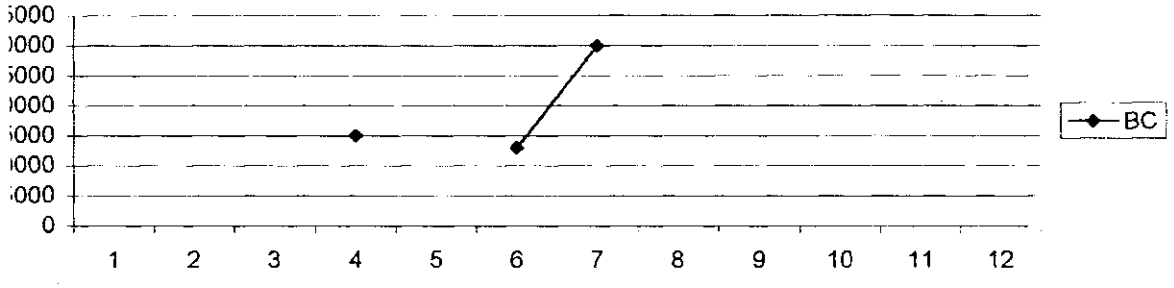

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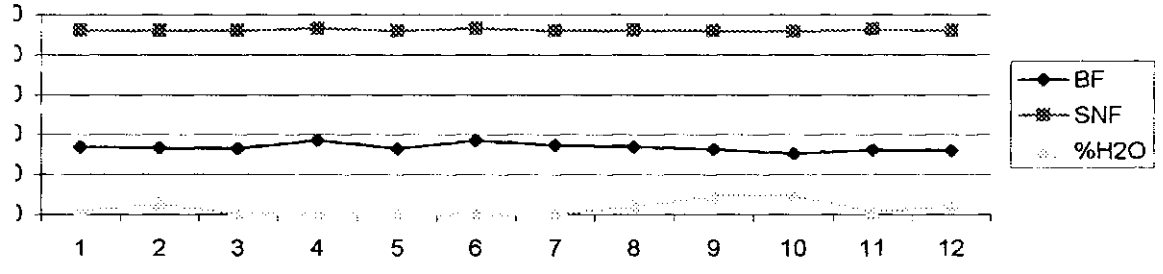

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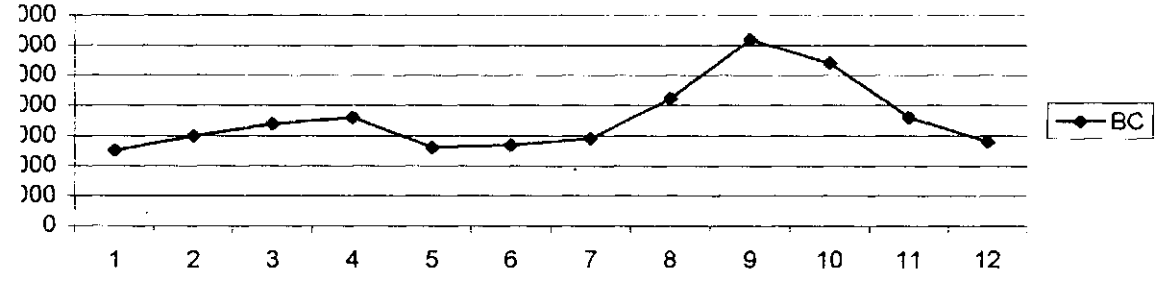

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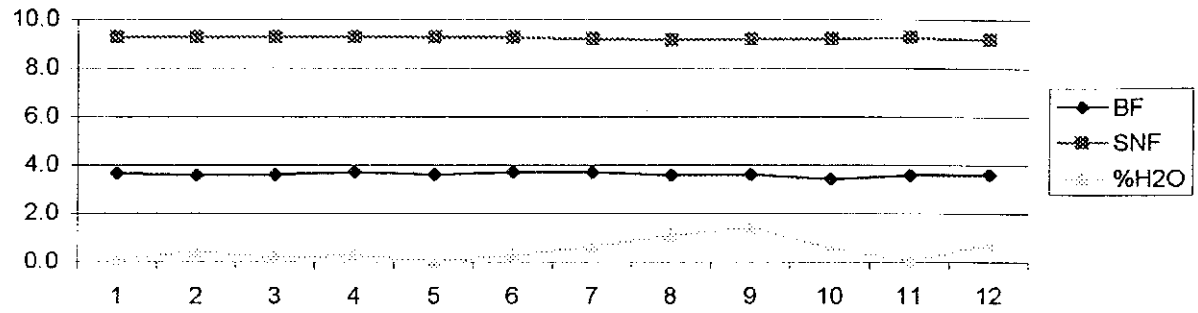

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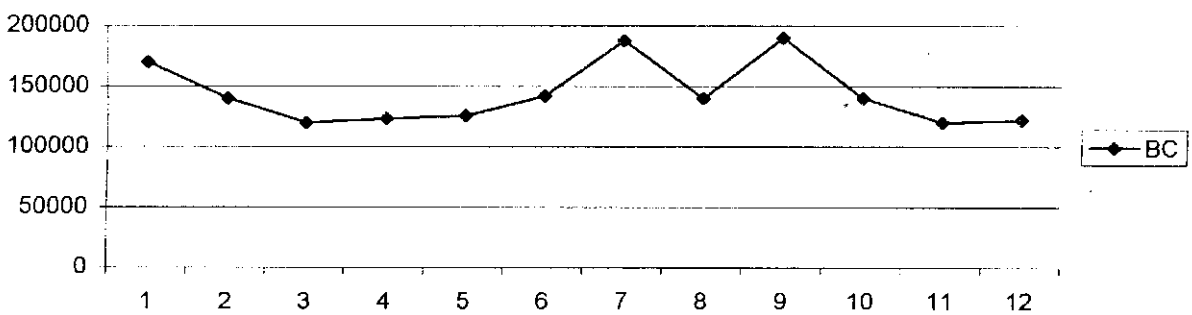

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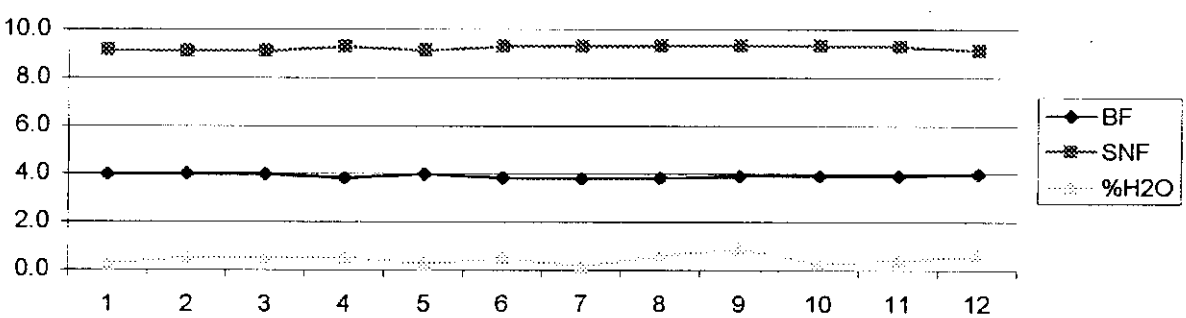

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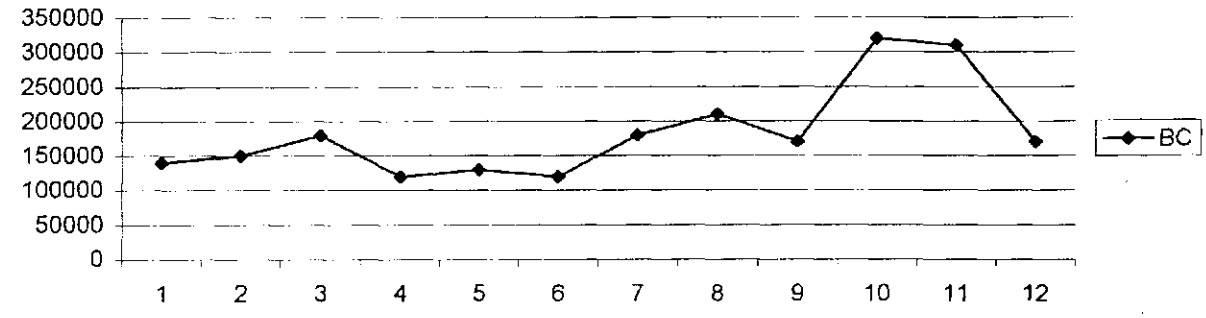

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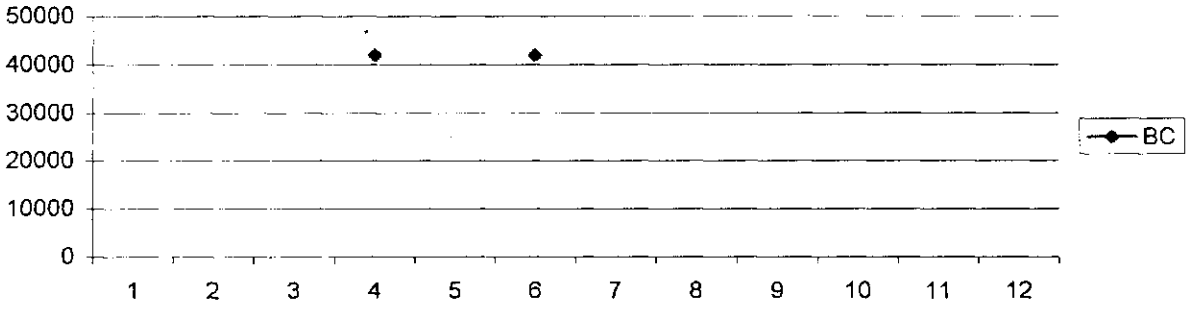

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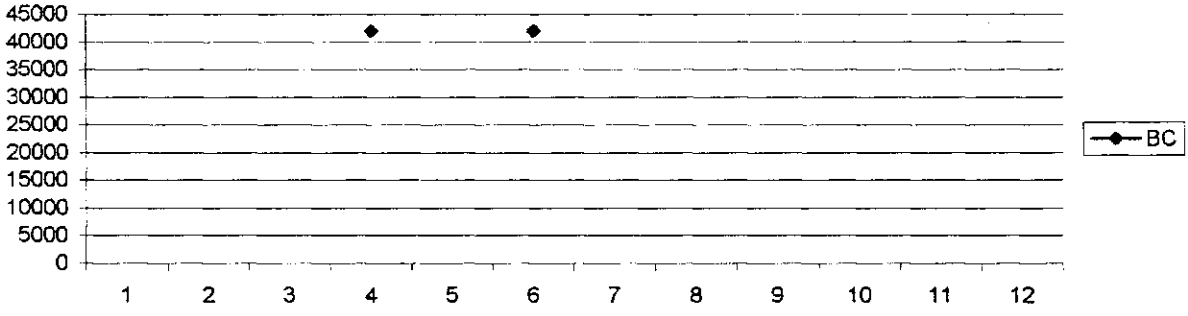

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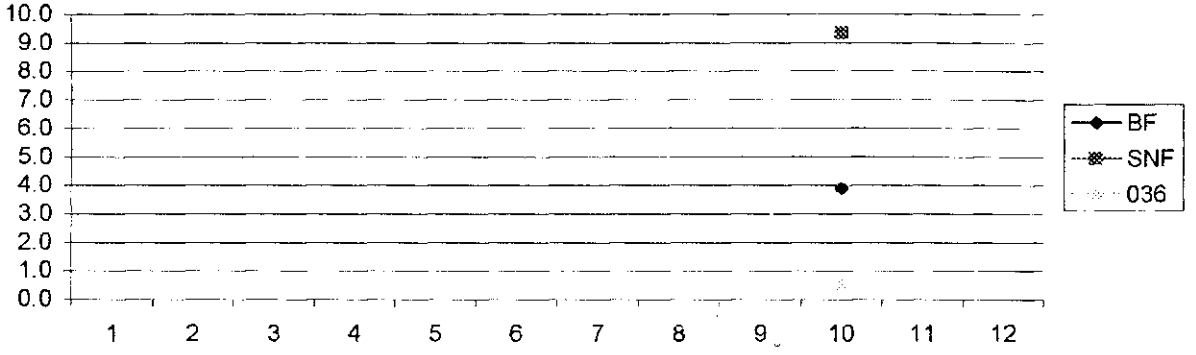

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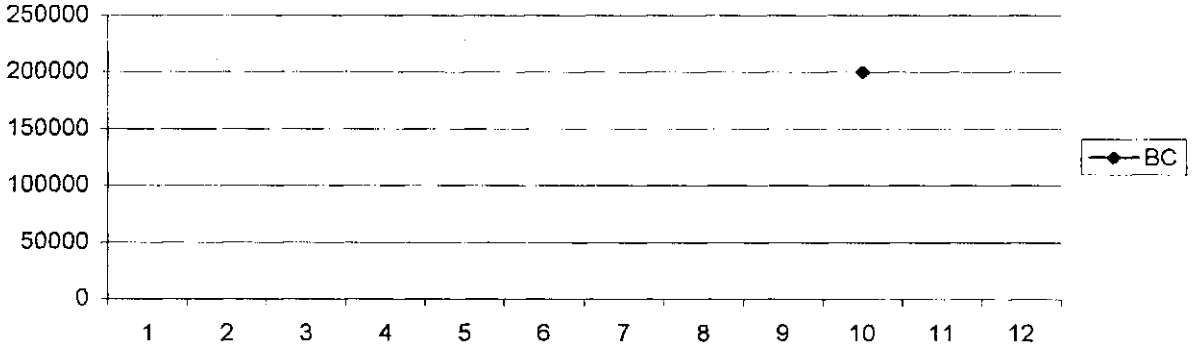

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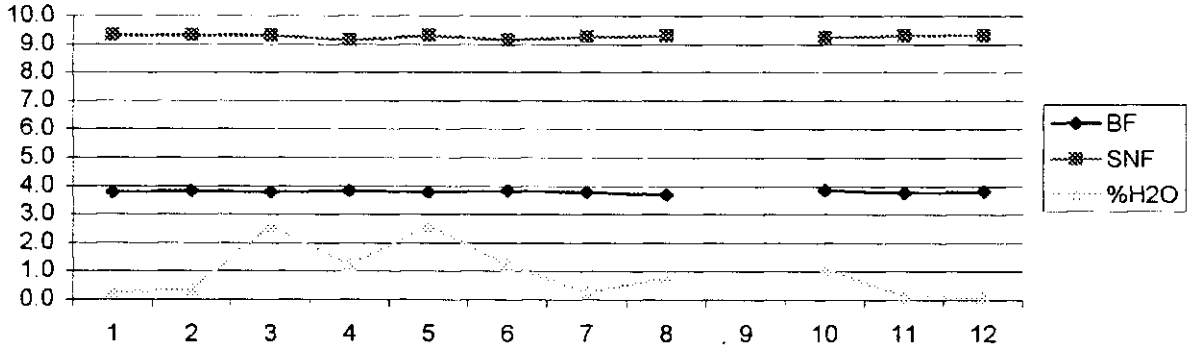

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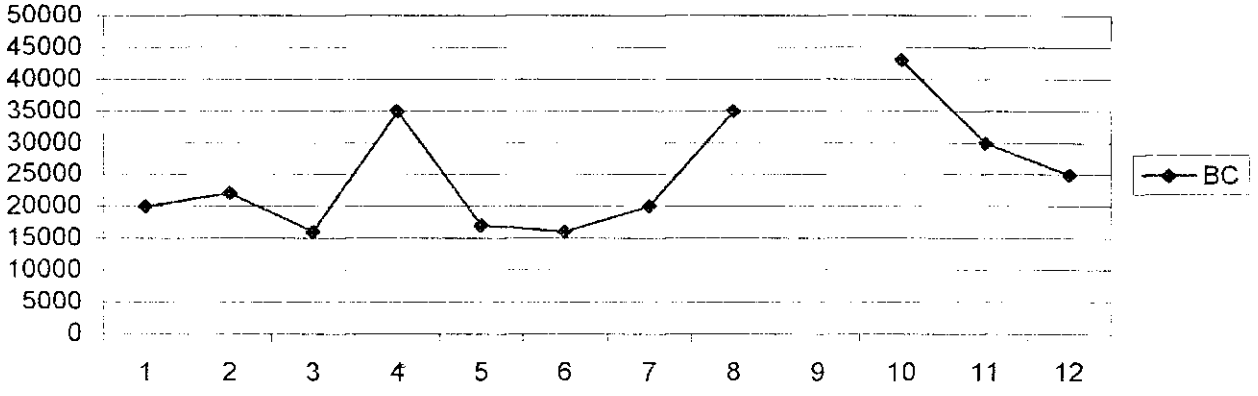

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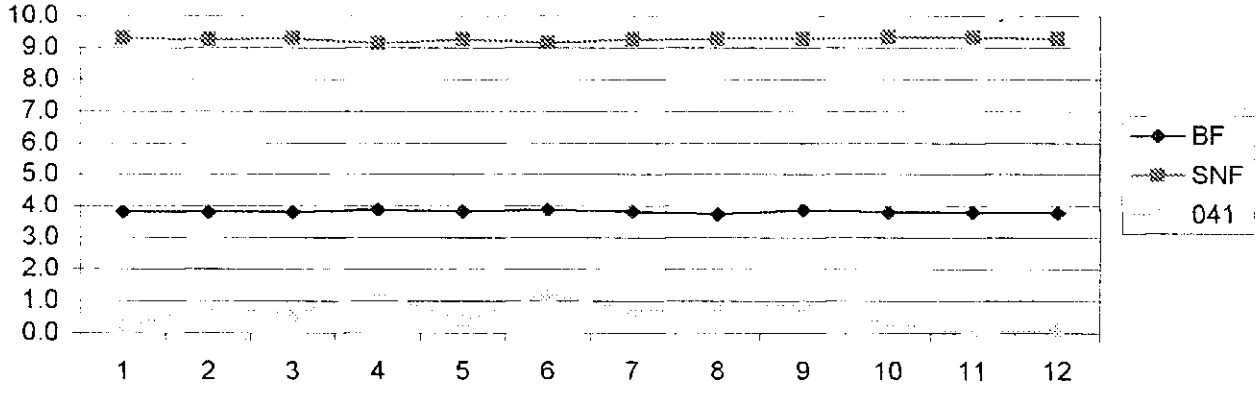

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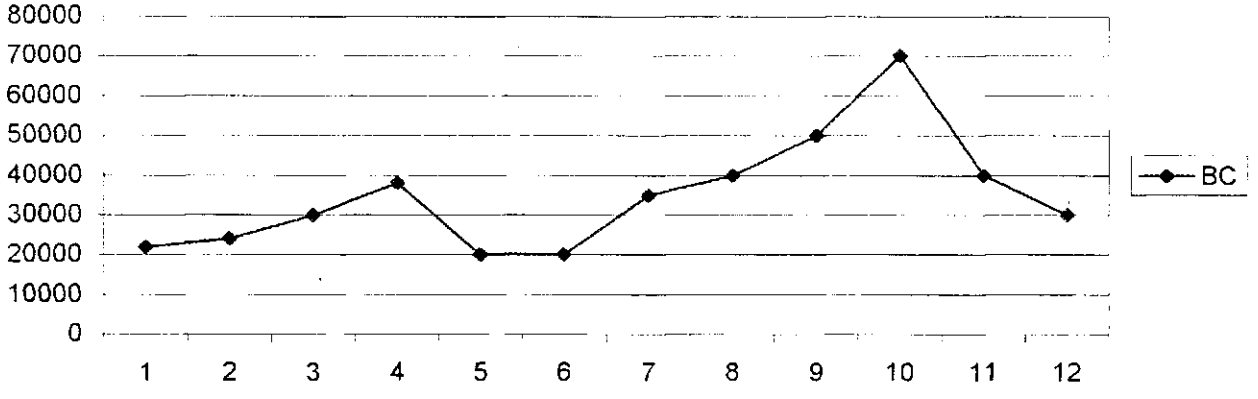

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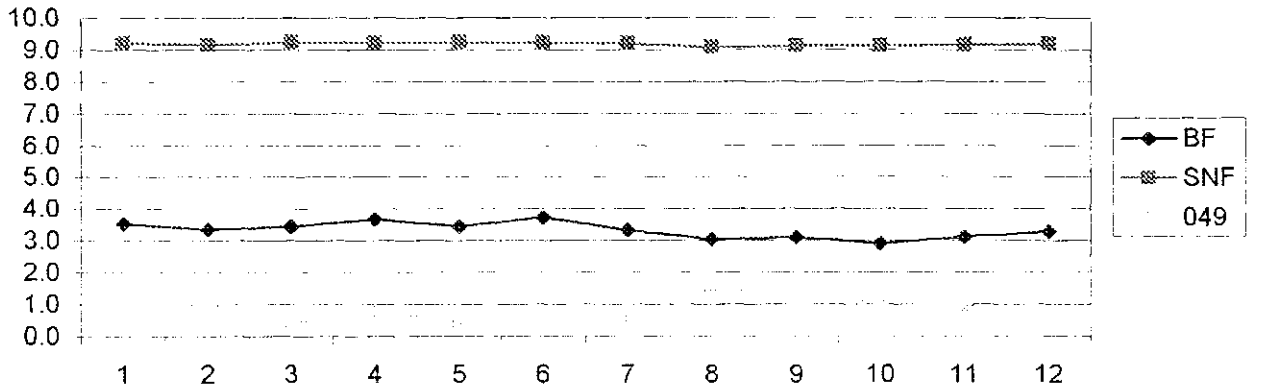

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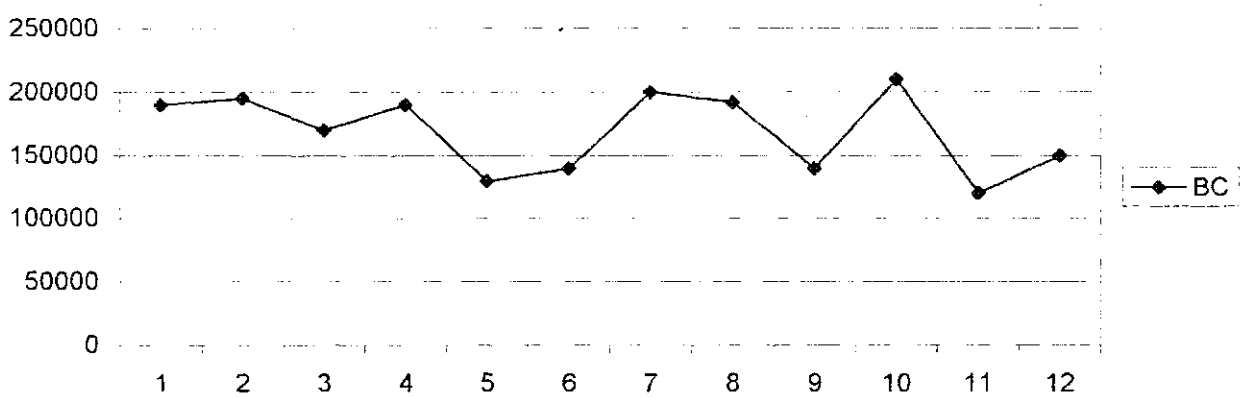

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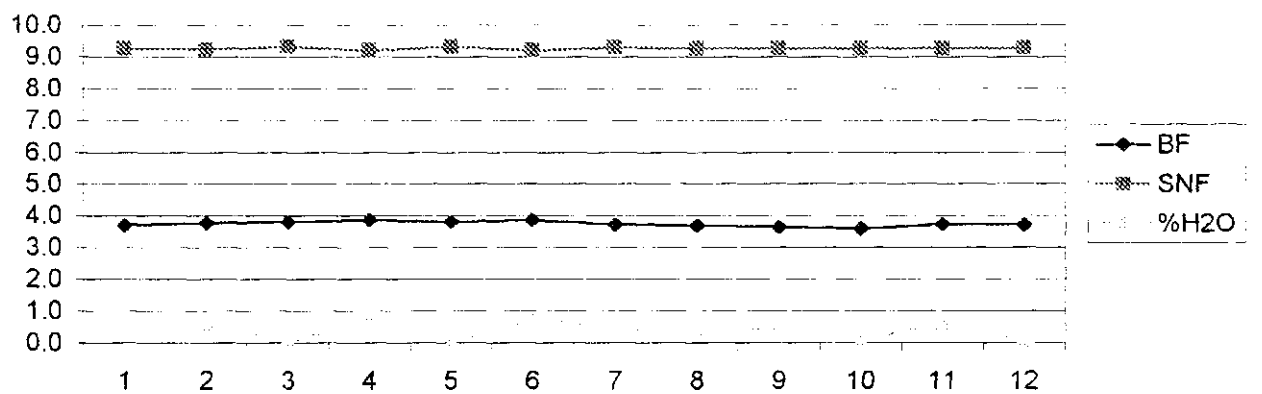

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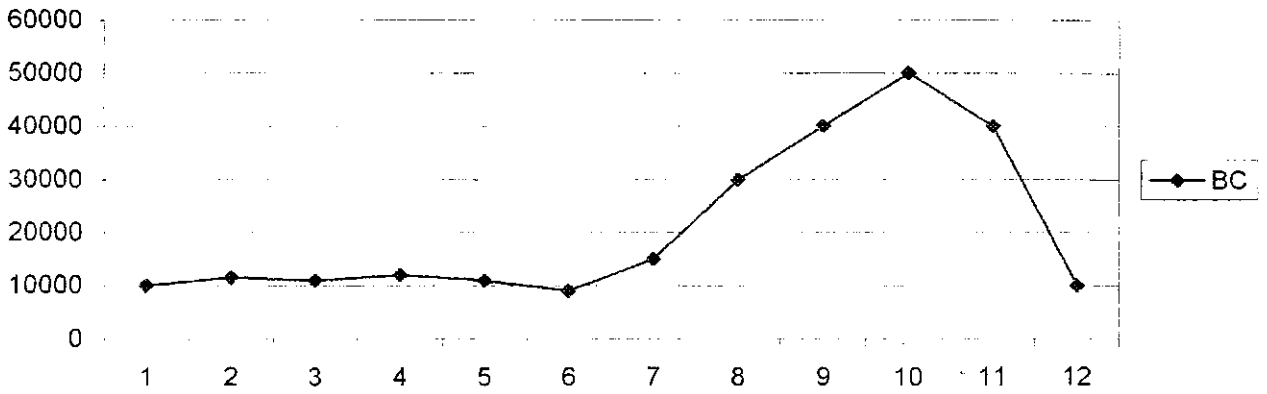

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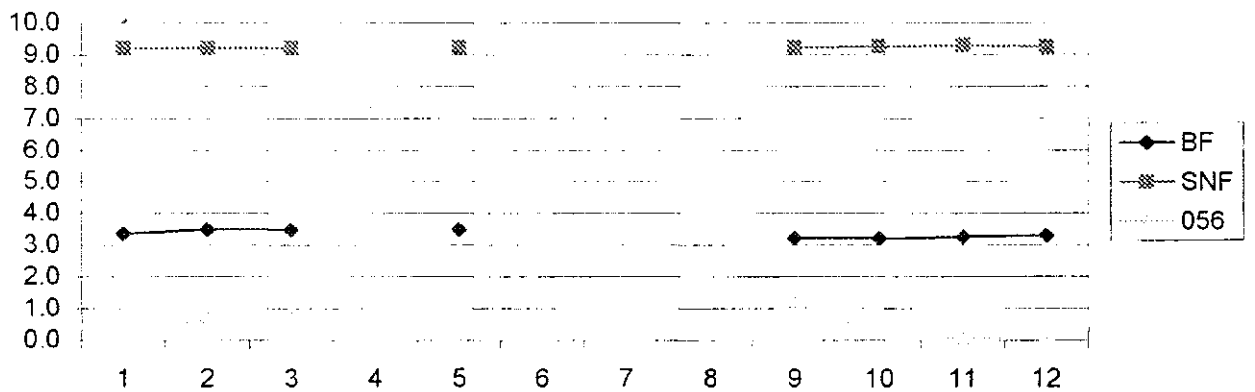

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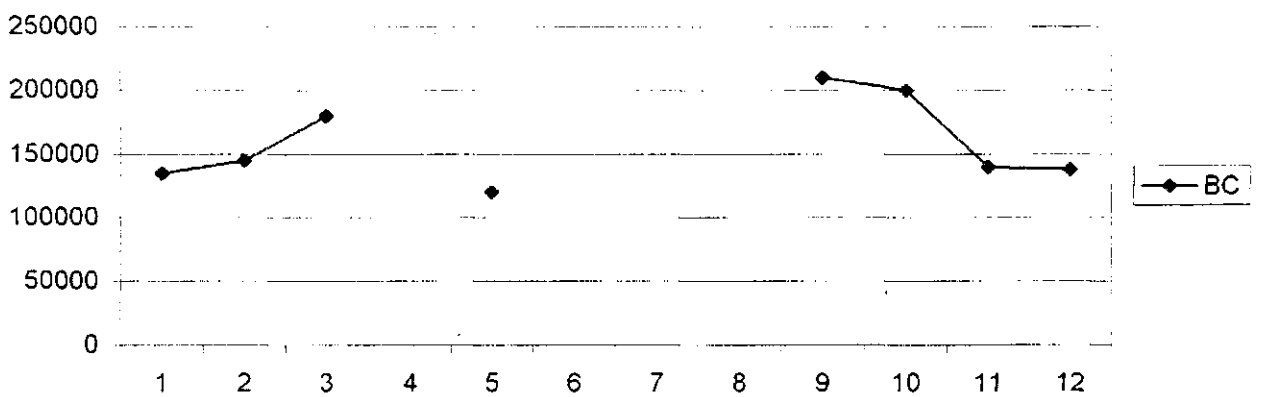

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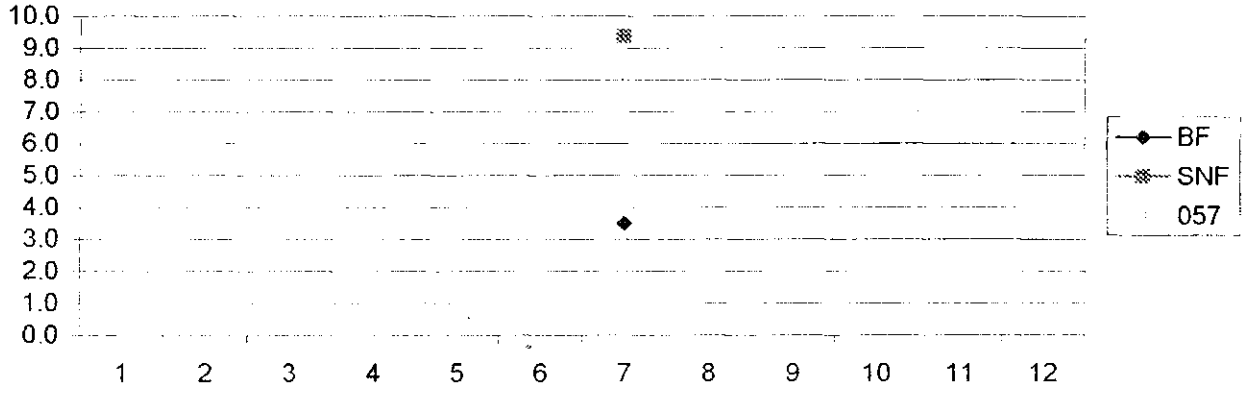

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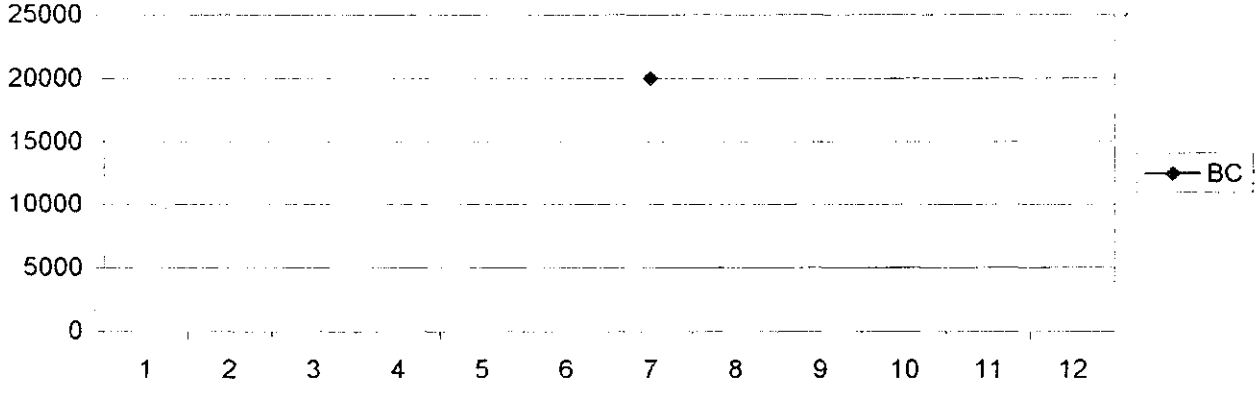

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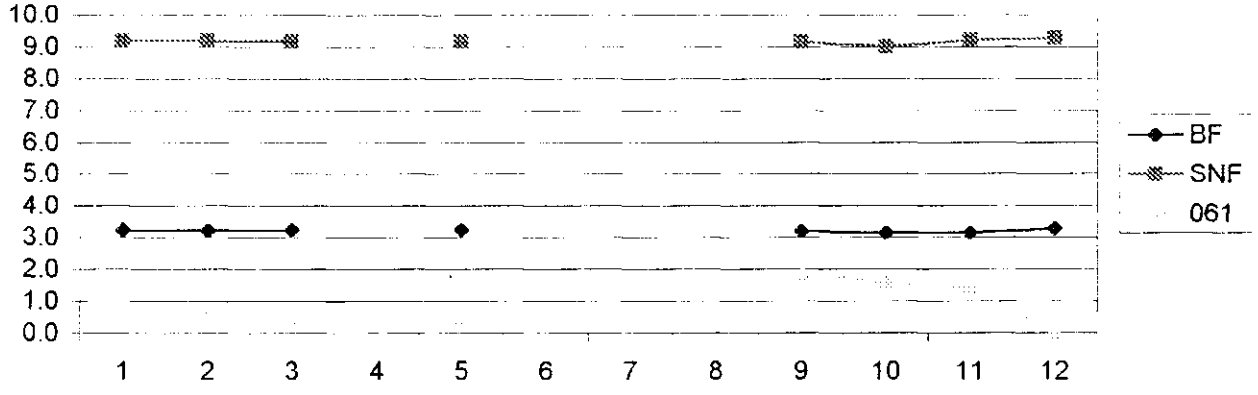

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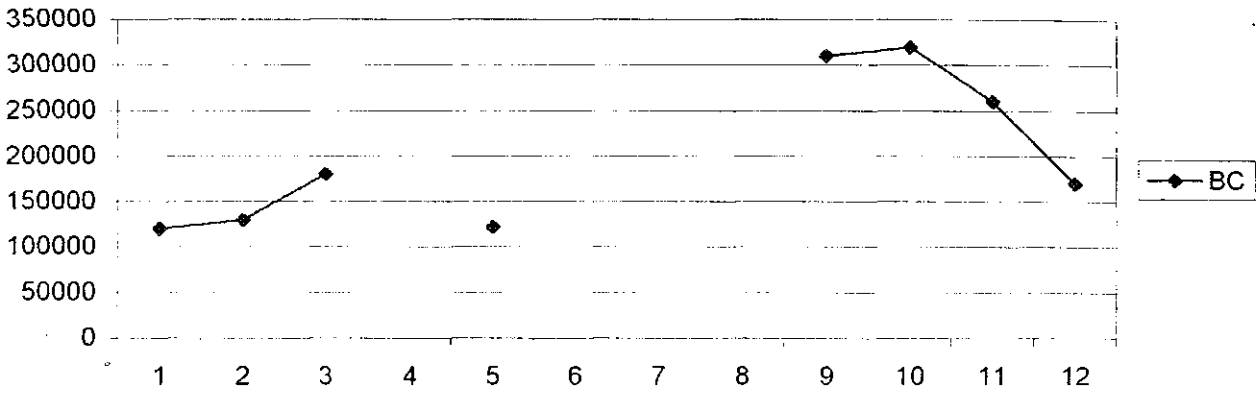

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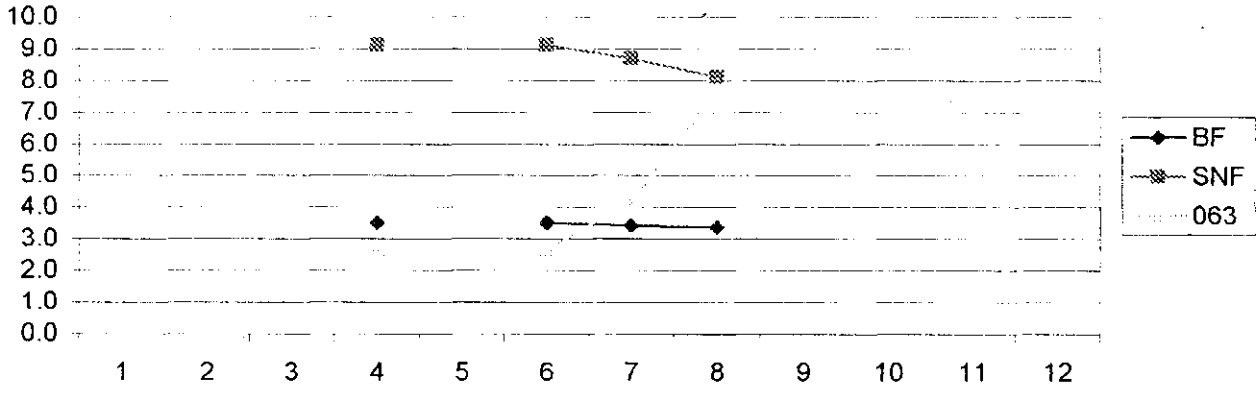

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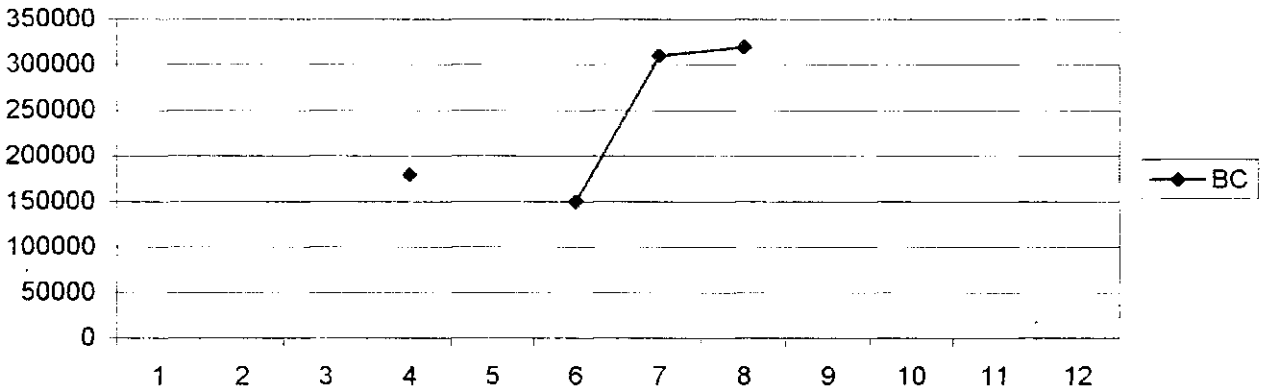

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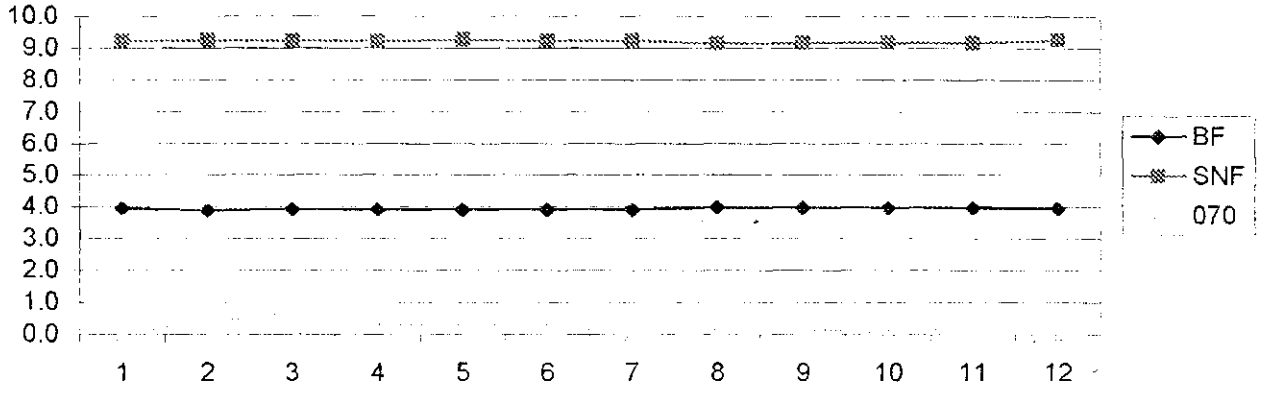

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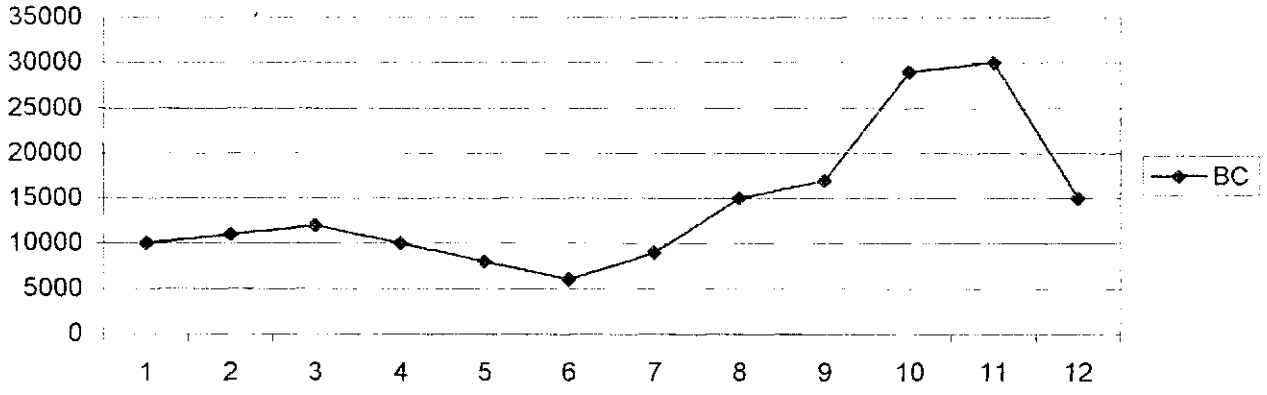

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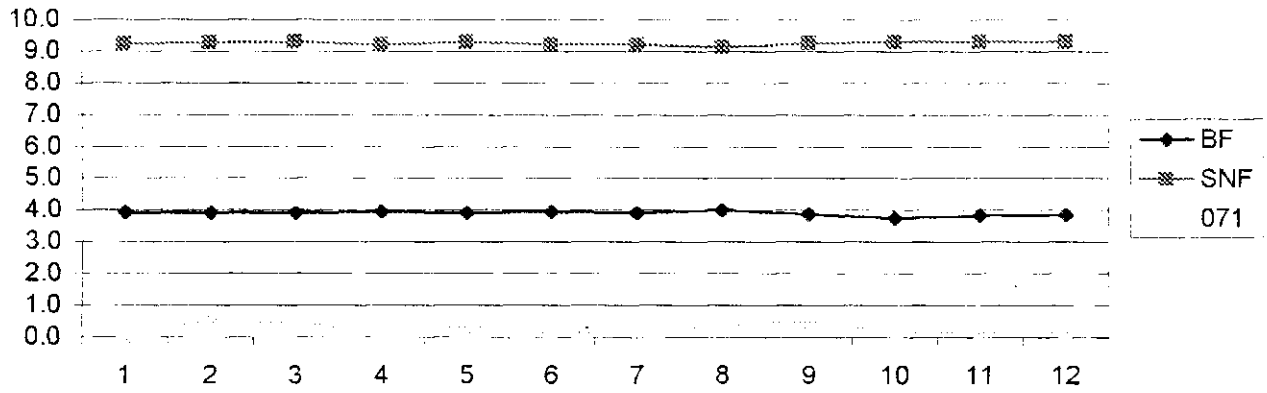

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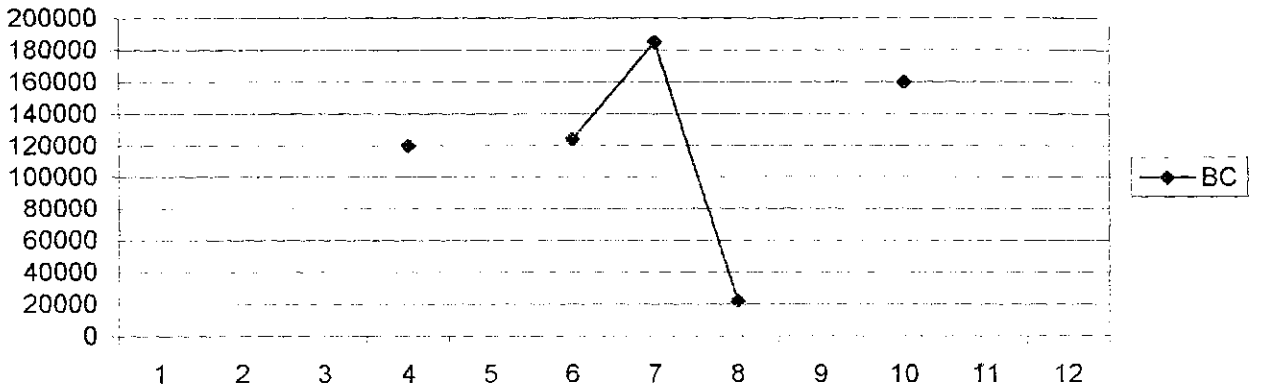

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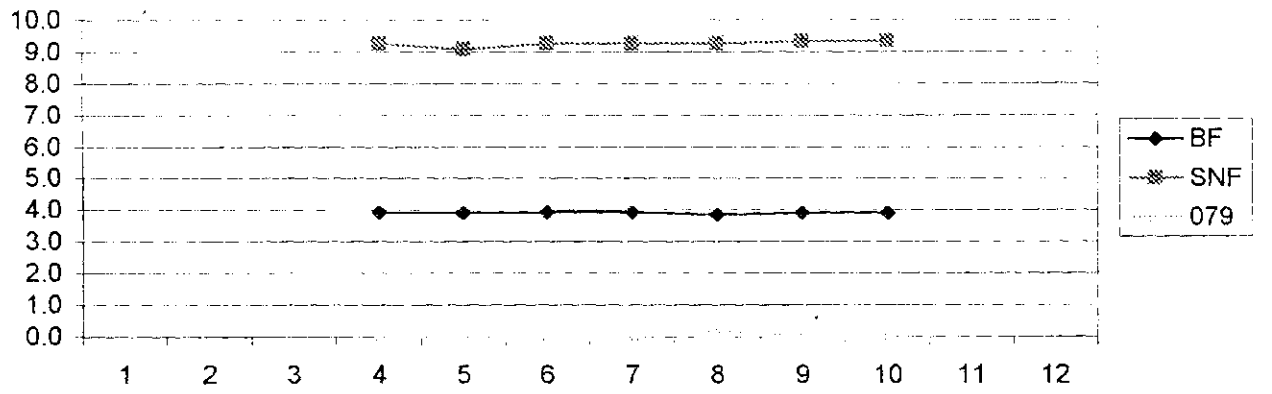

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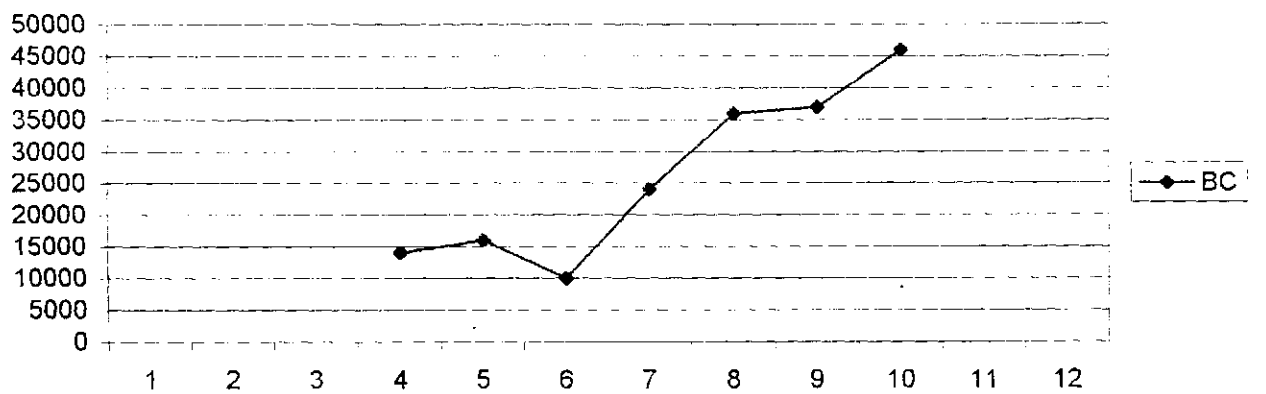

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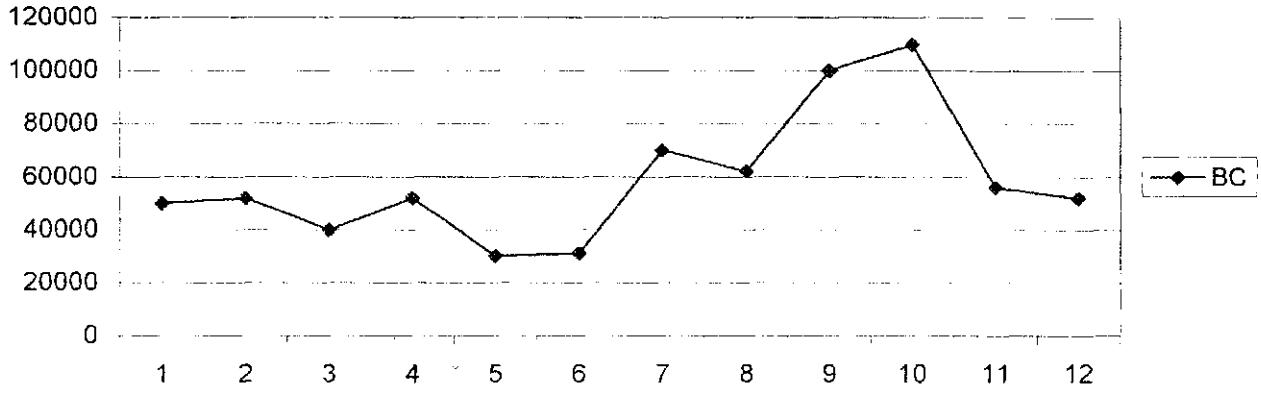

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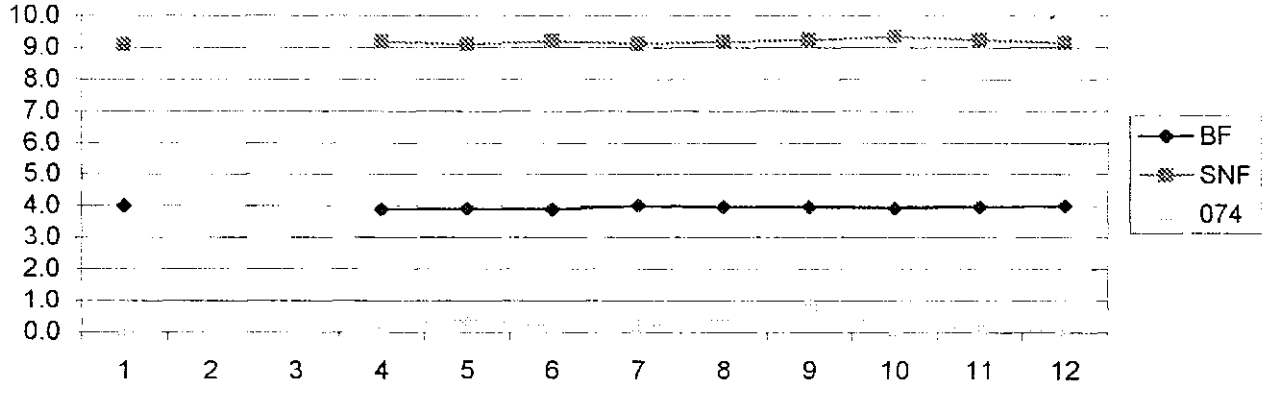

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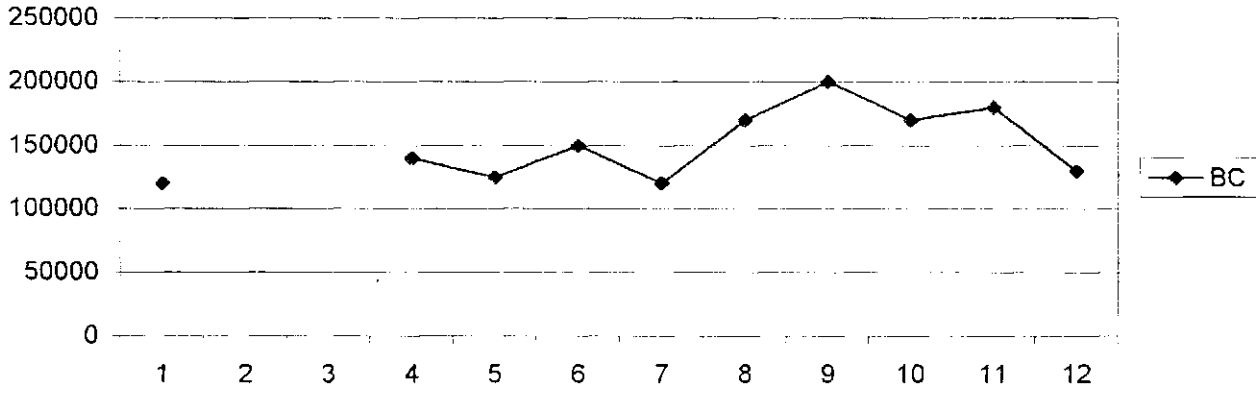

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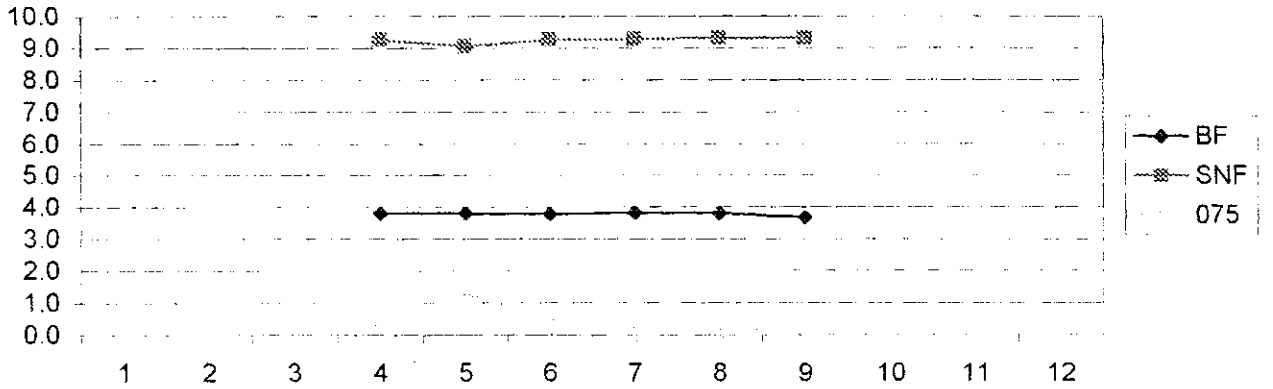

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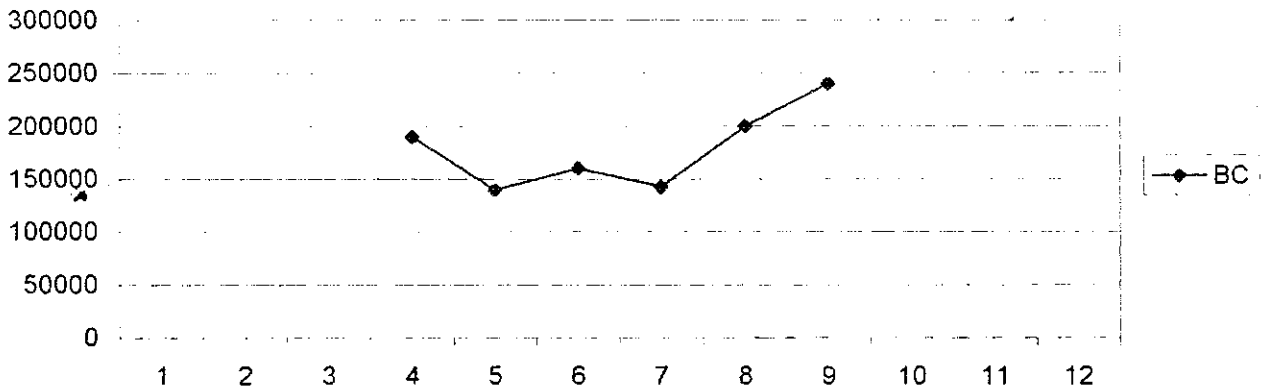

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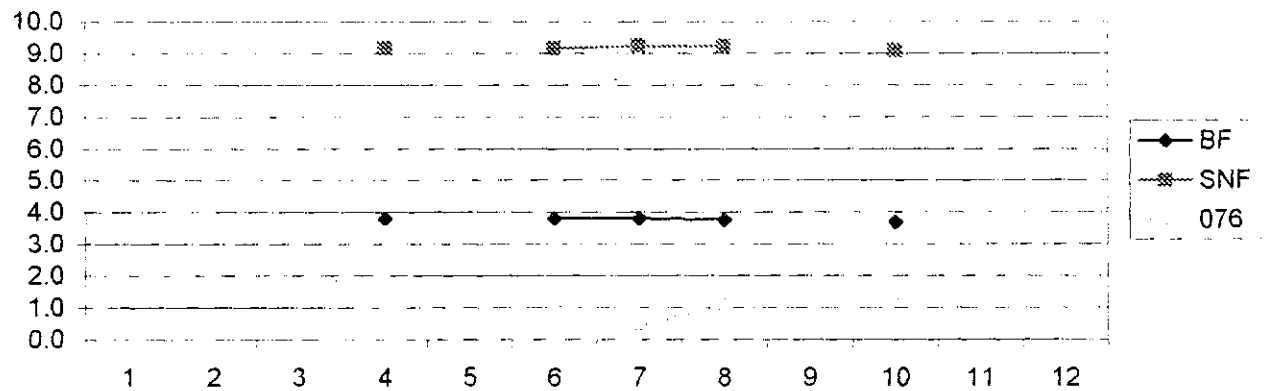

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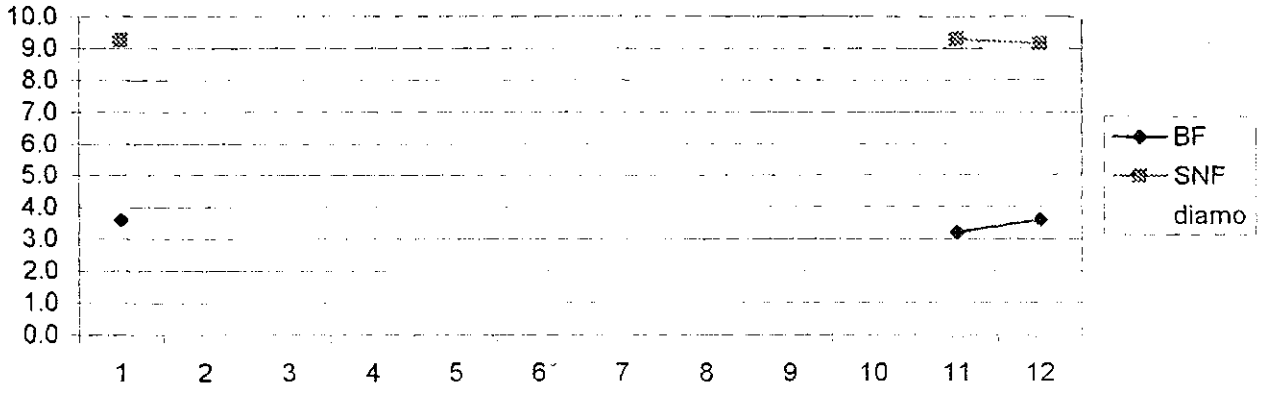

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