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ADVANCEMENT IN INDUSTRIAL METHOD OF *GHEE* MAKING PROCESS AT SARVOTTAM DAIRY, BHAVNAGAR, GUJARAT (INDIA)

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Abstract: *Ghee* is produced mainly by indigenous methods in Asia, the Middle-East and Africa and the methods of manufacture and characteristics vary. Several innovations aimed at increasing fat concentration, reduction of fat loss during processing and improving heat clarification of *ghee* can provide overall product improvement, increase product recovery, cut down production time, delight working conditions and result in an all overall process economy. Study was carried out to evaluate percentage fat loss, reduction of *ghee* residues, and physicochemical properties of *ghee* made by innovated method adopted by Sarvottam Dairy at Bhavnagar. The present study was also confined to sensory evaluation of *ghee* made by innovated method with earlier method.

Keywords: *Ghee*, Serum Separator, Cost effective, Fat loss, *Ghee* residues and SNF loss.

Introduction

The word *Ghee* comes from Sanskrit: *Ghṛta* ("*Gra*") meaning bright and has several names around the world. *Ghee* is an important part of Indian diet, religious, ceremonial function and therapeutic purposes. The characteristic flavor and aroma of *ghee* is its major criterion for acceptance. People have also cultivated a liking for the aroma and flavor of *ghee* and prefer it to vegetable oils and other traditional cooking medium. The nutritional value of *ghee* know since Vedic times in an ancient India [1]. Ayurveda describes *ghee* as a cool agent, which is capable of increasing mental power and physical strength. The medicine system has proposed its applications in many health disorders [2].

According to [3] *Ghee* is a pure clarified fat derived from milk and milk products. Chemically, *ghee* is a complex lipid of mixed glycerides together with a small amount of free fatty acids, phospholipids, sterols and their esters, fat soluble vitamins (A, D, E and K),

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carotenoids, carbonyl compounds, hydrocarbons, charred casein, moisture and traces of trace elements like copper and iron [4].

India is the largest milk producing country in the world. The total milk production during 2015-16 is to reach 155.49 million tonnes [5]. Among the indigenous milk products *ghee* production forms the largest segment. Its economic significance to the dairy industry can be realized from the fact that more than 30% of milk produced in India is converted to *ghee*. India produces 900,000 tonnes of marketed *ghee*, valued at Rs. 85,000 million. The market penetration of *ghee* is about 37% in urban areas and about 21% in rural areas [4]. Current Year; CY 2016 fluid milk production is projected to increase by 4.8 percent to 154 million tonnes and combined butter and *ghee* production is estimated to rise 3 percent to 5.2 MMT [6].

Ghee is broadly prepared by two methods namely traditional method and industrial method *viz.* creamery-butter method, direct cream method, pre-stratification method, and continuous method [7]. On the word of market dynamics more than 90% of the *ghee* is produced by traditional method by unorganized sectors in India by making *makkhan* and then converting it in to *ghee*.

At present scenario, the big challenge of organized sectors/Dairy Industries to competent their products with others in global markets with meets international standards.

Ghee is indigenous product and only 10% shared of organized sectors, so that it should be manufactured in such a manner that is cost effective, energy saving, and maximum yield without affecting of quality parameters of *ghee*. Several attempts have been made to modify, scale up and adopt for commercial and effective production of *ghee*. Because of commercial importance of *ghee* for Indian dairy industries considerable refinement and mechanization have taken place in manufacturing process and production of *ghee* received maximum research and development inputs. Increased awareness about energy management in the past motivated the research work to develop energy-efficient and continuous method for *ghee* manufacture [8], which used oil separator [9] to separate serum and fat phase or scrapped heat exchangers [10]. Both the process save energy and yield a comparable products.

Therefore, present study revel the cost effective manufacturing of *ghee* without affecting quality constraints by used of serum separator in Sarvottam Dairy, Bhavnagar, Gujarat (INDIA).

Serum separator manufacture by GEA, Mumbai, India was installed for improvement in process of *Ghee* making in middle of the month June 2016 at Sarvottam Dairy, Bhavnagar.

The main objective of installation was reduction of fat and SNF losses in production of *ghee* making. Data analysis was carried out to identify loss area throughout manufacturing of *ghee* on big scale.

Method of processing and process flow:

The entire process was finalized with inclusion of serum separator (SS) with butter melting vat and Spiro heaters (module 1 and module 2). The detailed flow diagram is given in Figure 1. Fresh raw milk is received at raw milk receiving dock (RMRD) by cans from different village level co-operative societies (VLCS) and directly received Raw Chilled milk (RCM) by milk tankers from milk chilling centre (MCC) to the main dairy plant; Savottam dairy, Sihor, Bhavnagar.

Raw milk is immediately chilled below 5℃ and stored in RCM silos. RCM is subjected to cream separation after necessary filtration and warming to 55-60℃ in regeneration section of pasteurizer. Resultant cream is pasteurized in a temperature at 78-84℃ for 16 sec. and cools to 10-12℃. Pasteurized fresh cream is stored in insulated cream storage tanks. This cream is then pumped to continuous Butter Making machine (CBMM) wherein white butter is obtained. Resultant buttermilk along with serum from serum separator (SS) is chilled in a plate chiller and diverted for use in standardization of fresh butter milk. Somewhere it may also be used in milk.

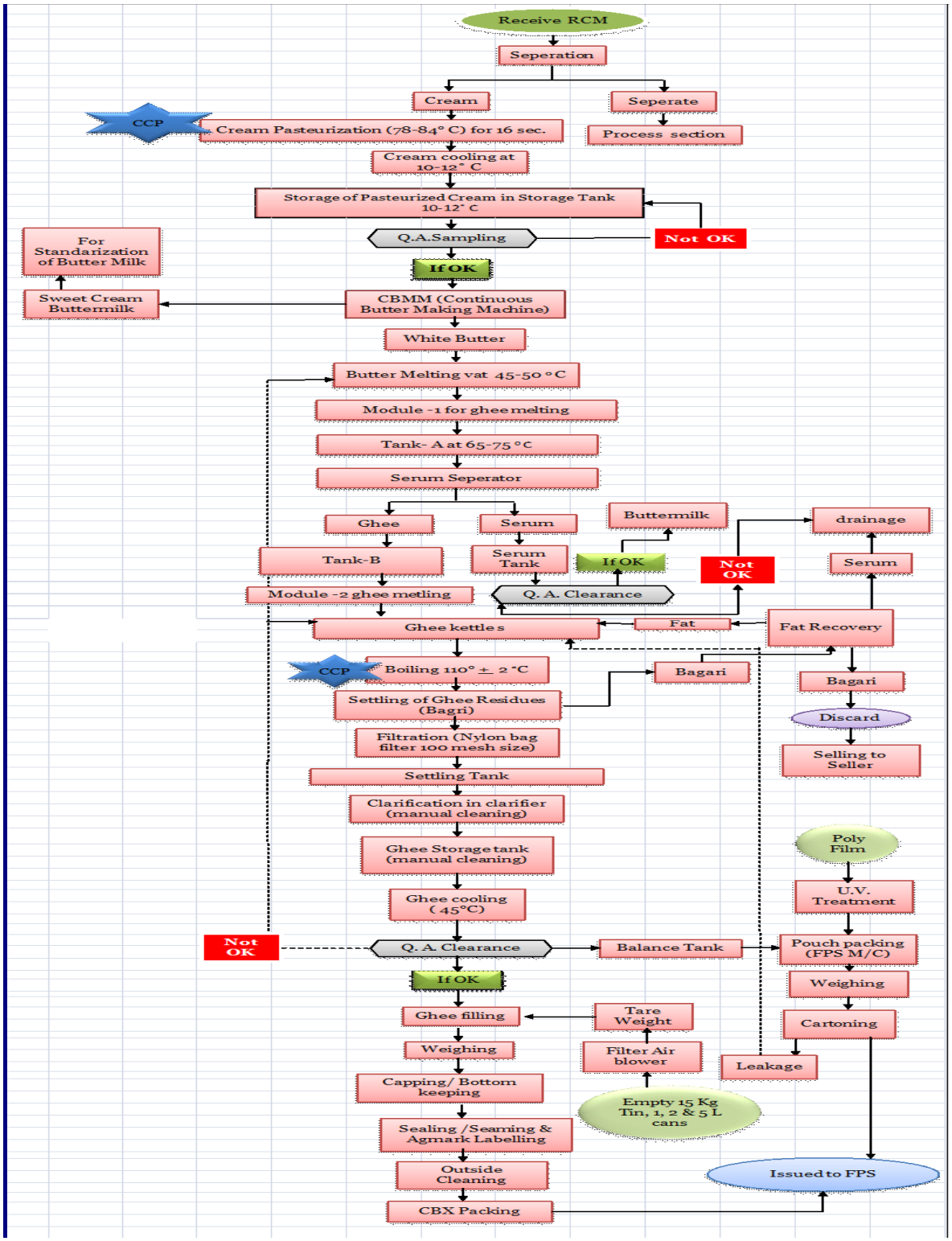

Figure 1: Process Flow Diagram

White butter is pumped via screw conveyor to melting vat where it melted at 45- 50 ºC; melted butter is pumped to Spiro-heater (module-1) where it is melted by circulating hot water. Melted butter is conveyed to Tank-A provided with agitator from where it is subjected to serum separation. Serum is separated, chilled in a plate chiller and pooled with sweet

buttermilk for use in butter milk standardization.

Melted butter with low moisture and high fat and serum solids is collected in a Tank-B after then it again passed through Spiro-heater (module-2) from where it is pumped to different *Ghee* kettles (boilers) for *ghee* manufacturing in a normal way during which residual moisture is evaporated at 110±2 ºC. After some holding, *ghee* clarification is done at 90 ºC through a *ghee* clarifier to remove fine particles of residue. Clarified *ghee* is pumped to *ghee* settling tanks where *ghee* is cooled with water circulation to 45 ºC. At this stage, a sample is withdrawn for analysis with respect to chemical constants and physical attributes before allowing it for packing into retail containers.

There are several benefits obtained by adopting this new methods commercially *Viz.* saving of fat, SNF, water, steam, electricity, time, and decrease load on ETP. Beyond these benefits, work conditions delight in the operators and workers of section.

Ghee filtration was also fast & efficient and *ghee* batch gets ready in half the time as compared to earlier method. Hygiene conditions and house-keeping are also improved in section.

Physicochemical analysis:

A chemical composition of serum part derived from serum separators is given in Table 1**.**

Table 1: Chemical composition of serum from Serum separator

Constituents	Serum
Fat	0.10±0.02%
SNF	5.63±0.5%
Titratable Acidity	0.074±0.010% L.A
Protein	2.46±0.30%
pH	6.6±0.1
Specific gravity	1.020±0.001

Values are means ± SD (n=4)

Analysis of physicochemical properties of *ghee* made by advanced method revealed that FFA, RM value, P value, BR reading, moisture, Boudin test, texture and color residues at par with Ag-mark and FSSAI standards. Relative details of physicochemical data are tabulated in Table 2**.**

Table 2: Physico-chemical properties of *ghee* made by innovated method with Ag-mark and FSSAI standards

Characteristics	**Innovated method of *Ghee* [1]**	**Ag-mark (Spl. Grade)**	**FSSAI (for Gujarat region)**
Baudouin test	Negative	Negative	Negative
Butyro-refractometer (BR) reading at 40 C	41.72	40.0-43.0	Area other than cotton tract areas- 40 to 43.5 cotton tract areas-41.5 to 45
Reichert Meissl (RM) value	29.82	Not less than 28.0	Not less than 21.0 (cotton tract areas) Not less than 24.0 (Area other than cotton tract areas)
Polenske (P) value	1.51	1.0-2.0	-
Moisture content	0.09	Not more than 0.3%	Not more than 0.5%
Percentage of Free Fatty Acid (FFA) (as oleic acid)	0.12	Not more than 1.4	Not more than 3%
Texture* (*When cooled below the melting point)	Proper granulation	The solid phase shall be of well defined granular structures	-
Color	White with yellowish tint and Added coloring matter - absent	White with or without yellowish or greenish tint, and shall be uniform throughout	Added coloring matter- Absent

[1] All values are average of month

Fat analysis:

Fat loss during processing of *ghee* directly affects the productivity of plant. Therefore, percentage of fat loss study was carried out for earlier method and adopted new innovated method. An entire study was carried out from month of April to September 2016.

In reference to [11] *ghee* defined as an almost anhydrous fat which is only produced in India. *Ghee* is often used as a synonym for different dairy products, *e.g.* clarified butter [12; 13], butter fat [14], Indian butter oil [15], butter oil, anhydrous milk fat [16] and Indian *ghee* [12; 13]. [17] defined *ghee* as a fat-rich dairy product obtained by a process of heat clarification and desiccation.

Data generated for fat loss percentage by using earlier and innovated method for *ghee* making process were analyzed. Percentage fat loss observed by earlier method in month April, May,

June were 2.04, 2.35, 2.36 respectively and by innovated method in month July, August, September were 0.26, 0.10, 0.30 respectively. The change in Percentage fat loss content follows the linear trained as observed by establishing the equation with R^2 value 0.70 as presented in Figure 2**.**

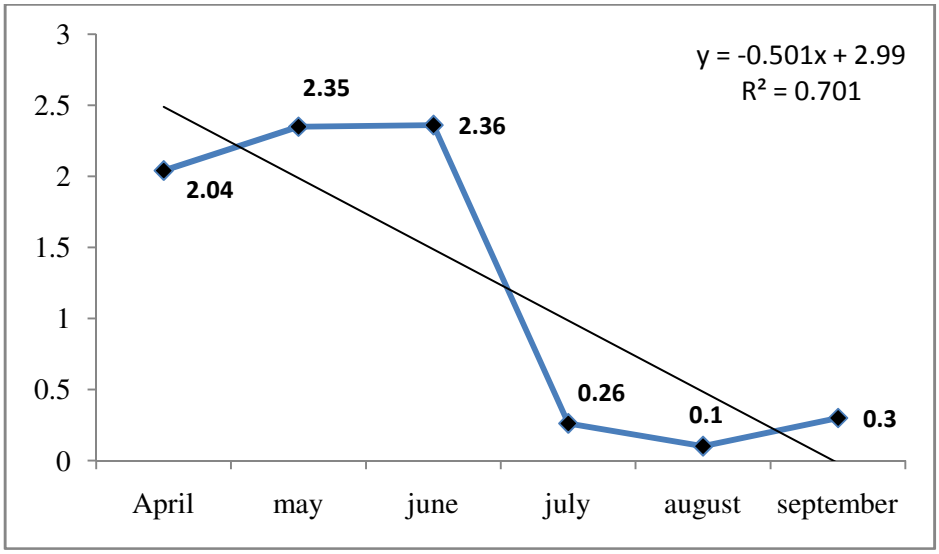

Figure 2: Percentage fat loss

***Ghee* residues (*Bagari*) analysis:**

Ghee residues analysis was also carried out for both methods *viz.* earlier and innovated method during same period of months. Percentage of *Ghee* residue (*Bagari*) dispatch to third party observed by earlier method in month April, May, June were 0.80, 0.6, 0.61 respectively and by innovated method in month July, August, September were 0.50, 0.46, 0.22 respectively. The change in percentage of *ghee* residue dispatched follows the linear trained as observed by establishing the equation with R^2 value 0.90 as presented in Figure 3**.**

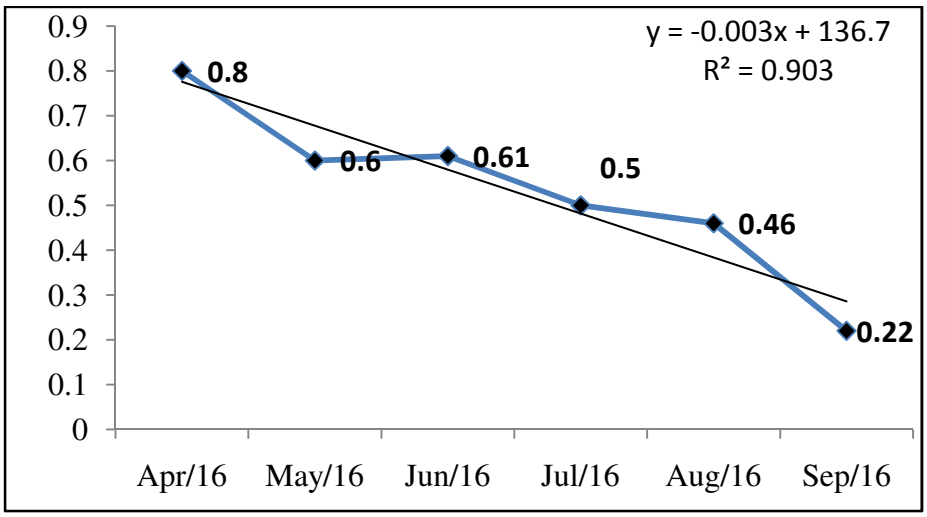

Figure 3: *Ghee* residues (Bagari; in %) dispatch

Sensory evaluations:

Sensory analysis was carried out for Innovated *ghee* sample (*Ghee*-A) and earlier method *ghee* samples (*Ghee*-B) using 100-point scales by a panel of 05 semi-trained judges. All samples were evaluated for flavor, texture, color and free from suspended impurities.

Both samples were served for sensory evaluation on 100 point scale as per IS; 7770; 1975. Innovated method *ghee* samples scored 42, 22, 8.6, and 9.4 in comparison to earlier method *ghee* sample that scored 43, 25, 8.2, and 9.4 on flavor, texture, color and free from suspended impurities respectively as Figure 4.

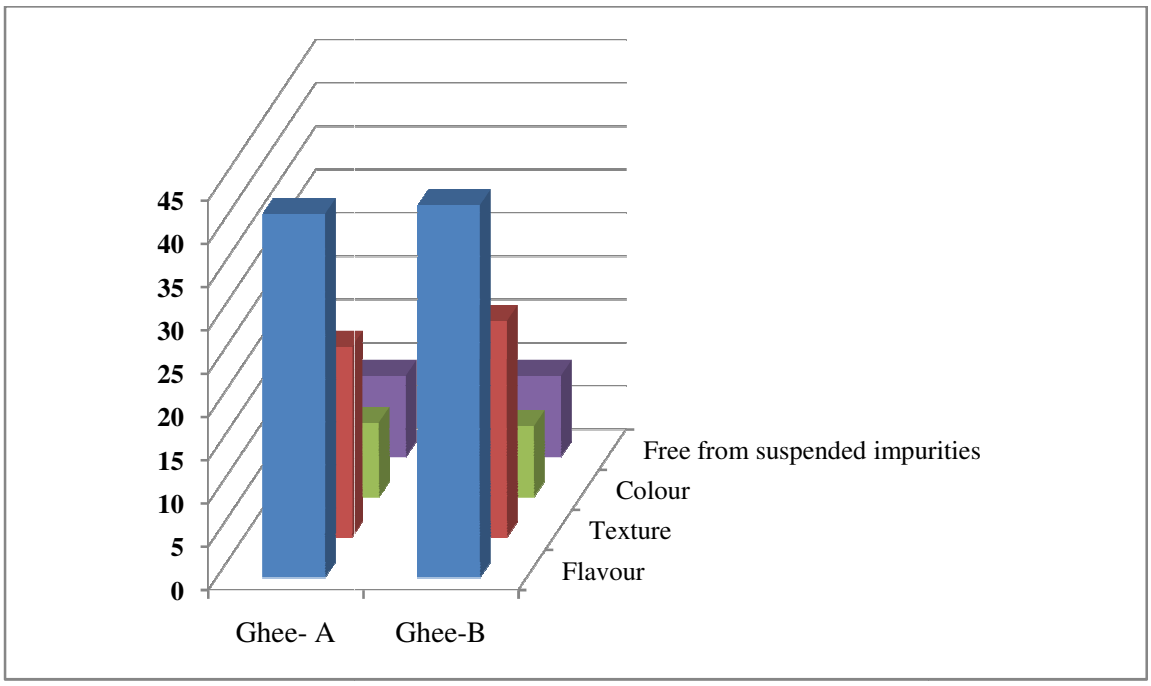

Figure 4: Sensory score of Ghee samples

Conclusion

All physicochemical properties of *ghee* made by innovated method were at par with Ag-mark and FSSAI standards. Fat loss during processing are dramatically reduced in comparison to earlier method. *Ghee* made by this process has no more residues other than *ghee* fat; Innovated method has less scraping in *ghee* boilers due to less *ghee* residue. Sensory studies reveal all sensory attributes of innovated method *ghee* samples were at par relative to earlier method *ghee* samples. Since last one year Sarvottam Dairy is making *ghee* using this innovated process.

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