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Sonia Mor
Ph. D Scholar,
Division of Dairy Chemistry,
National Dairy Research Institute, Karnal, Haryana, India

Vivek Sharma
Principal Scientist,
Division of Dairy Chemistry,
National Dairy Research Institute, Karnal, Haryana, India

Sumit Arora
Principal Scientist,
Division of Dairy Chemistry,
National Dairy Research Institute, Karnal, Haryana, India

Correspondence
Vivek Sharma
Principal Scientist,
Division of Dairy Chemistry,
National Dairy Research Institute, Karnal (Haryana), India

Effect of season, heat clarification temperature and ripening of cream on physico-chemical parameters of Ghee

Sonia Mor, Vivek Sharma and Sumit Arora

Abstract
In this experiment effect of season, heat clarification temperature and ripening of cream on physico-chemical parameters of Ghee viz. BR reading, RM value, Polenske value and Kirschner value was seen. The raw milk samples were collected from Livestock Research Centre of NDRI, Karnal on bimonthly basis and Ghee samples were prepared in laboratory using creamery butter method from (ripened/fresh) cream by giving different heat clarification temperature. It was observed that effect of season was visible on BR reading, RM value, Polenske value and Kirschner value of cow Ghee and buffalo Ghee whereas ripening of cream as well as heat clarification temperature did not cause any significant effect on different physico-chemical parameters. The results showed that highest B.R. reading for cow and buffalo Ghee was observed in month of February-March (42.93±0.004 and 43.22±0.004), RM value in the month of February-March (30.45±0.31) and Dec-Jan (35.64±0.28), Polenske value in Dec-Jan (1.83±0.04 and 1.43±0.04) Kirschner value in Aug-Sep (22.96±0.23 and 30.30±0.03), respectively.

Keywords: Ghee, physico-chemical parameters, season

Introduction
Ghee, widely considered as the Indian name for clarified butterfat, is usually prepared from cow milk or buffalo milk or combination thereof. Ghee production forms the largest segment of the milk consumption and utilization pattern in India. It is the second largest consumed dairy product in India after liquid milk. It has been reported that about 30-35% of milk produced in India is converted into Ghee (Pawar *et al*. 2012) [1] and it is considered as the supreme cooking and frying medium. In its table use, Ghee is served in hot melted form and used for garnishing rice or spreading lightly on chapattis. Ghee contributes significantly towards nourishment of people of all age groups. It is a good source of fat-soluble vitamins (A, D, E and K) and essential fatty acids (Rangappa and Achaya 1974) [2].Therefore, the quality of Ghee produced should meet the compositional standards specified under FSSAI rules, 2011 (as amended from time to time) irrespective of method used for preparation, season, heat clarification temperature or whether cream used for preparation of Ghee was fresh or ripened. So for that purpose, in present study different factors effecting the physico-chemical parameters of Ghee like effect of ripening and non-ripening of cream, heat clarification temperature and seasonal variations were studied.

Materials and Methods
Collection and preparation of samples
Cow and buffalo milks used for the preparation of respective Ghee samples were collected bimonthly up to complete eight months (in August-September, October-November, December-January and February-March) from the Livestock Research Centre, NDRI, Karnal. Samples of cow/buffalo Ghee were prepared by creamery butter method (De, 2010) [3]. Soon after the collection of milk samples, these were warmed to 40°C and separated into cream using mechanical cream separator. The cream was pasteurized at 77˚C for 5 minutes, cooled to room temperature and it was separated into two batches. One batch was ripened using the culture M-167 taken from NCDC, NDRI at 21˚C for 14hrs and second batch of cream was kept in a refrigerator (5 to 10˚ C) for few hours (3 to 5 hours) for aging. Butter was prepared from both the batches of cream under standard conditions (9°C in summer and 13°C in winter) by churning of cream using hand operated butter churn. The butter was then heated on direct

flame in a stainless-steel vessel and clarified into Ghee with continuous stirring at two different temperatures of 110°C/flash and 130°C/flash. Ghee was then filtered through 6-8-fold muslin cloth followed by further filtration by using Whatman No.4 filter paper in glass vacuum assembly and finally filled in plastic bottles, cooled to room temperature and kept in a refrigerator at a temperature of 5 to 10°C till further analysis.

Analysis

The physico-chemical constants such as Reichert-Meissl (RM) value, Polenske value (PV) and Butyro-refractometer reading of samples were determined by the methods as described in SP: 18 (Part XI) – 1981 (BIS, 1981) [4]. Kirschner Value (K) was determined by the method of Ghatak and Bandyopadhya (2007) [5].

Result & Discussion

Effect of season on Butyro-refractometer (B.R) reading of cow

The average of Butyro-refractometer (B.R.) reading in different periods of the year of cow Ghee and buffalo Ghee clarified at 110˚C and 130˚C are presented in the tables1 and 2. It can be seen from the table1 that B.R. reading of cow Ghee clarified at 110˚C was highest in the month of February-March (42.89±0.004) and lowest in month of December-January (42.18±0.004) and cow Ghee clarified at 130˚C was highest in the month of February-March (42.93±0.004) and lowest in month of December-January (42.21±0.004). Analysis of variance of the data (Table1) revealed that B.R. reading of pure cow Ghee prepared from ripened cream differed significantly (P< 0.05) in all the months. Perusal of the data revealed that in both the cases i.e. Ghee clarified at 110˚C and 130˚C, the effect of season was visible. B.R. reading got affected as a result of season. Results obtained in the present study; on the B.R. reading of cow Ghee is in general agreement with those reported by Kumar (2013) [6].

Table 1: Butyro-refractometer (B.R.) reading of cow Ghee clarified at 110˚C and 130˚C

Temperature of Clarification	Sample Intervals				
	AUG-SEP	OCT-NOV	DEC-JAN	FEB-MAR	CD value (P≤0.05)
110˚C	42.84±0.004^{b}	42.27±0.004^{c}	42.18±0.004^{d}	42.89±0.004^{a}	0.0108
130˚C	42.89±0.004^{b}	42.34±0.004^{c}	42.21±0.004^{d}	42.93±0.004^{a}	0.0108

Data presented is mean ± SE of three determinations

Values bearing different superscripts in each row differ significantly

Effect of season on Butyro-refractometer (B.R) reading of buffalo Ghee

It can be seen from the table 2 that B.R. reading of buffalo Ghee clarified at 110˚C was highest in the month of February-March (42.22±0.004) and lowest in month of August-September (41.29±0.004) and Ghee clarified at 130˚C was highest in the month of February-March (42.17±0.004) and lowest in month of August-September (41.25±0.004). Analysis of variance of the data (Table 2) showed the B.R. reading of ripened buffalo Ghee also differed significantly (P< 0.05) in all the months. This trend was similar to the trend observed in case of cow Ghee. In both the cases B.R. reading was meeting the FSSAI standards of Ghee for northern India i.e.40- 43 at 40˚C. Perusal of the data also revealed that average B.R. reading of pure cow Ghee was slightly higher than the B.R. reading of pure buffalo Ghee as cow Ghee contained higher amount of unsaturated fatty acids and lower amount of saturated fatty acids compared to buffalo Ghee (Blasi *et al.*, 2008[7]; Menard *et al.*, 2010 [8]).

Table 2: Butyro-refractometer (B.R.) reading of buffalo Ghee clarified at 110˚C and 130˚C

Temperature of Clarification	Sample Intervals				
	Aug-Sep	**Oct-Nov**	**Dec-Jan**	**Feb-Mar**	**CD value (P≤0.05)**
110˚C	41.29±0.004^{d}	41.48±0.00^{c}	41.91±0.00^{b}	42.22±0.00^{a}	0.0108
130˚C	41.25±0.004^{d}	41.55±0.00^{c}	41.95±0.00^{a}	42.17±0.00^{a}	0.0108

Data presented is mean ± SE of three determinations

Values bearing different superscripts in each row differ significantly

Effect of temperature of clarification on Butyro-refractometer (B.R) reading of cow and buffalo Ghee

The overall average B.R. reading of cow Ghee and buffalo Ghee prepared and clarified at 110˚C and 130˚C are presented in the tables 3 and 4. Analysis of variance of the data (Table 3) for B.R. reading revealed that cow Ghee clarified at 110˚C did not differ significantly (P< 0.05) from the Ghee clarified at 130˚C. Similarly, the B.R. reading of buffalo Ghee clarified at 110˚C did not differ significantly (P< 0.05) from the Ghee clarified at 130˚C. Perusal of the data revealed that temperature of clarification did not affect the B.R. reading of Ghee. However, Bector and Narayanan, 1974 [9] reported a slight increase in B.R. reading when clarification temperature was increased. In the present case, also a slight increase in B.R. reading is observed in absolute values but statistically it was not significant.

Table 3: Butyro-refractometer (B.R.) reading of cow and buffalo Ghee clarified at 110˚C and 130˚C

Temperature of Clarification	Samples	
	Cow Ghee	**Buffalo Ghee**
110˚C	42.63±0.090^{a}	41.50±0.189^{a}
130˚C	42.71±0.089 ^{a}	41.61±0.132^{a}
CD value (P≤0.05)	0.248	0.453

Data presented is mean ± SE of 24 determinations

Values bearing different superscripts in each column differ significantly

Effect of Ripening on Butyro-refractometer (B.R) reading of cow and buffalo Ghee

The overall average of Butyro-refractometer (B.R.) reading along with standard error of cow and buffalo Ghee prepared from ripened and fresh cream and clarified at 110˚C and 130˚C are presented in the table 4. Analysis of variance of the data (Table 4) revealed that B.R. reading of pure cow Ghee prepared from ripened cream clarified at 110˚C did not differ significantly (P< 0.05) from the Ghee which was prepared from the fresh cream. Similarly, the B.R. reading of pure cow Ghee prepared from ripened cream clarified at 130˚C did not differ significantly (P< 0.05) from the B.R. reading of Ghee prepared from fresh cream and clarified at 130˚C. Similarly, in case of buffalo Ghee no significant difference (P< 0.05) was observed in B.R. reading of Ghee prepared from ripened and fresh cream. Therefore, it can be concluded that ripening of cream before the preparation of Ghee did not change the B.R. readings of respective Ghee samples significantly.

Table 4: Butyro-refractometer (B.R.) reading of ripened and fresh cow and buffalo Ghee clarified at 110˚C and 130˚C

Process	Cow Ghee		Buffalo Ghee	
	Temp. of Clarification		Temp. of Clarification	
	110˚C	130˚C	110˚C	130˚C
UNRIPENING	42.72±0.153 [a]	42.83±0.147[a]	41.28±0.365[a]	41.50±0.247[a]
RIPENING	42.54±0.101 [a]	42.59±0.101 [a]	41.73±0.115[a]	41.73±0.111[a]
CD value (P≤0.05)	0.364	0.353	0.758	0.537

Data presented is mean ± SE of 12 determinations

Values bearing different superscripts in each column differ significantly

Effect of season on Reichert-Meissl (RM) value of cow Ghee

The average of Reichert-Meissl (RM) value in different periods of the year of cow and buffalo Ghee clarified at 110˚C and 130˚C are presented in the tables 5 and 6. It can be seen from the table 5 that RM value of cow Ghee clarified at 110˚C was highest in the month of February-March (30.45±0.31) and lowest in month of August-September (28.18±0.22). Analysis of variance of the data (Table 5) revealed that R.M. value of cow Ghee in August-September and October-November differed significantly (P< 0.05) from RM value in December-January and February-March but R.M. value did not differ significantly in August-September from October–November and December-January from February-March. It can also be seen from the table 5 that RM value of cow Ghee clarified at 130˚C was highest in the month of December-January (30.14±0.14), which was almost similar to the reading obtained in month of February-March (30.13±0.31) and lowest in month of October–November (28.03±0.37). Analysis of variance of the data (Table 5) revealed that R.M. value of cow Ghee in August-September and October-November differed significantly (P< 0.05) from RM value in December-January and February-March but R.M. value of August-September from October–November and December-January from February-March did not differ significantly. Perusal of the data revealed that in both the cases i.e. Ghee clarified at 110˚C and 130˚C, the effect of season was visible. RM value got affected as a result of season.

Table 5: Reichert-Meissl (RM) value of cow Ghee clarified at 110˚C and 130˚C

Temperature of Clarification	Sample Intervals				
	Aug-Sep	Oct-Nov	Dec-Jan	Feb-Mar	CD value (P≤0.05)
Temp-110˚C	28.18±0.22 [b]	28.64±0.31[b]	29.82±0.17[a]	30.45±0.31 [a]	0.705
Temp-130˚C	28.29±0.21 [b]	28.03±0.37[b]	30.14±0.14[a]	30.13±0.22 [a]	0.674

Data presented is mean ± SE of three determinations

Values bearing different superscripts in each row differ significantly

Effect of season on Reichert-Meissl (RM) value of buffalo

It can be seen from the table 6 that RM value of pure buffalo Ghee clarified at 110˚C was highest in the month of December-January (34.78±0.09) and lowest in month of October–November (32.01±0.08) and Ghee clarified at 130˚C was highest in the month of December-January (34.91±0.03) and lowest in month of October–November (32.12±0.08). Analysis of variance of the data (Table 6) revealed that R.M. value of pure buffalo Ghee prepared from ripened cream differed significantly (P< 0.05) in all months whereas no significant difference was observed in RM value in December-January and February-March.

Table 6: Reichert-Meissl (RM) value of buffalo Ghee clarified at 110˚C and 130˚C

Temperature of Clarification	Sample Intervals				
	AUG-SEP	OCT-NOV	DEC-JAN	FEB-MAR	CD value (P≤0.05)
Temp-110˚C	34.21±0.146[b]	32.01±0.08[c]	34.78±0.09[a]	34.55±0.04 [a]	0.267
Temp-130˚C	34.32±0.090[b]	32.12±0.02[c]	34.91±0.03[a]	34.75±0.08 [a]	0.178

Data presented is mean ± SE of three determinations

Values bearing different superscripts in each row differ significantly

Effect of temperature of clarification on Reichert-Meissl (RM) value of pure cow and buffalo Ghee

The overall average RM value of cow Ghee and buffalo Ghee prepared and clarified at 110˚C and 130˚C are presented in the tables 7 and 8. Analysis of variance of the data (Table 7) for RM value revealed that cow Ghee clarified at 110˚C did not differ significantly (P< 0.05) from the Ghee clarified at 130˚C. Similarly, the RM value of buffalo Ghee clarified at 110˚C did not differ significantly (P< 0.05) from the Ghee clarified at 130˚C. Perusal of the data revealed that temperature of clarification did not affect the RM value of Ghee. Results obtained in the present study on RM value are in general agreement with those reported by Bector and Narayanan, 1974 [9] that clarification temperature did not affect the RM value.

Table 7: Reichert-Meissl (RM) value of pure cow and buffalo Ghee clarified at 110˚C and 130˚C

Temperature of Clarification	Samples	
	Cow Ghee	Buffalo Ghee
110˚C	28.98±0.174 [a]	34.66±0.481 [a]
130˚C	28.86±0.181 [a]	34.27±0.224
CD value(P≤0.05)	0.494	1.045

Data presented is mean ± SE of 24 determinations
Values bearing different superscripts in each column differ significantly

Effect of Ripening on Reichert-Meissl (RM) value of cow and buffalo Ghee

The overall average of RM value along with standard error of cow and buffalo Ghee prepared from ripened and fresh cream and clarified at 110˚C and 130˚C are presented in the table 8. Analysis of variance of the data (Table 8) revealed that RM value of cow Ghee prepared from ripened cream clarified at 110˚C did not differ significantly (P< 0.05) from the Ghee which was prepared from the fresh cream. Similarly, the RM value of cow Ghee prepared from ripened cream clarified at 130˚C did not differ significantly (P< 0.05) from the RM value of Ghee prepared from fresh cream and clarified at 130˚C. Similarly, in case of buffalo Ghee no significant difference (P< 0.05) was observed in RM value of Ghee prepared from ripened and fresh cream. Therefore, it can be concluded that ripening of cream before the preparation of Ghee did not change the RM value of respective Ghee samples significantly.

Table 8: Reichert-Meissl (RM) value of ripened and fresh cow and buffalo Ghee clarified at 110˚C and 130˚C

Process	COW GHEE		BUFFALO GHEE	
	Temp. of Clarification		Temp. of Clarification	
	110˚C	130˚C	110˚C	130˚C
Unripening	28.69±0.160 [a]	28.58±0.142 [a]	35.43±0.878 [a]	34.52±0.287[a]
Ripening	29.27±0.301 [a]	29.15±0.326 [a]	33.89±0.349 [a]	34.03±0.354[a]
CD value(P≤0.05)	0.676	0.705	1.876	0.904

Data presented is mean ± SE of 12 determinations
Values bearing different superscripts in each column differ significantly

Effect of season on Polenske value (PV) of cow Ghee

The average of Polenske value in different periods of the year of cow and buffalo Ghee clarified at 110˚C and 130˚C are presented in the tables 9 and 10. It can be seen from the table 9 that Polenske value of cow Ghee clarified at 110˚C was highest in the month of December-January (1.73±0.04) and lowest in month of August-September (1.37±0.04). Analysis of variance of the data (Table 9) revealed that Polenske value of pure cow Ghee prepared from ripened cream in August-September did not differ significantly (P< 0.05) from Polenske value in October –November and Polenske value in December-January did not differ significantly (P< 0.05) from Polenske value in February-March but Polenske value in August-September and October–November differ significantly from December-January and February-March. This may be attributed to the effect of diet on Polenske value. It can also be seen from the table 9 that Polenske value of cow Ghee clarified at 130˚C was highest in the month of December-January (1.83±0.04) and lowest in month of October–November (1.47±0.04). Analysis of variance of the data (Table 9) revealed that Polenske value of cow Ghee in August-September, October-November and December-January did not differ significantly (P< 0.05) from each other. Perusal of the data revealed that in both the cases i.e. Ghee clarified at 110˚C and 130˚C, the effect of season was visible. Polenske value got affected as a result of season. Results obtained in the present study; on the Polenske value of cow Ghee is in general agreement with those reported by Kumar (2013) [6], Rangappa and Achaya (1974) [2].

Table 9: Polenske value (PV) of cow Ghee clarified at 110˚C and 130˚C

Temperature of Clarification	Sample Intervals				
	AUG-SEP	OCT-NOV	DEC-JAN	FEB-MAR	CD value (P≤0.05)
Temp-110˚C	1.37±0.04 [b]	1.47±0.04 [b]	1.73±0.04 [a]	1.67±0.04 [a]	0.108
Temp-130˚C	1.57±0.04 [b]	1.47±0.04 [b]	1.83±0.04 [a]	1.57±0.04 [b]	0.108

Data presented is mean ± SE of three determinations
Values bearing different superscripts in each row differ significantly

Effect of season on Polenske value (PV) of buffalo Ghee

It can be seen from the table 10 that Polenske value of buffalo Ghee clarified at 110˚C was highest in the month of December-January (1.37±0.041) and lowest in month of August-September and February-March (1.23±0.041). Analysis of variance of the data (Table 10) revealed that Polenske value of buffalo Ghee differed significantly (P< 0.05) in all months whereas no significant difference in Polenske value was observed in August-September and February-March. It can also be seen from the table 10 that Polenske value of buffalo Ghee clarified at 130˚C was highest in the month of December-January (1.43±0.041) and lowest in month of October–November (1.23±0.041). Analysis of variance of the data (Table 10) revealed that Polenske value of buffalo Ghee differed significantly (P< 0.05) in all months.

Table 10: Polenske value (PV) of buffalo Ghee clarified at 110˚C and 130˚C

Temperature of Clarification	Sample Intervals				
	AUG-SEP	OCT-NOV	DEC-JAN	FEB-MAR	CD value (P≤0.05)
Temp-110˚C	1.23±0.041 [b]	1.27±0.041[ab]	1.37±0.041[a]	1.23±0.041 [b]	0.108
Temp-130˚C	1.30±0.071[ab]	1.23±0.041 [b]	1.43±0.041[a]	1.33±0.082[ab]	0.163

Data presented is mean ± SE of three determinations
Values bearing different superscripts in each row differ significantly

Effect of temperature of clarification on Polenske value (PV) of cow and buffalo Ghee

The overall average Polenske value of cow Ghee and buffalo Ghee prepared and clarified at 110˚C and 130˚C are presented in the table 11 and 12. Analysis of variance of the data (Table 11) for Polenske value revealed that cow Ghee clarified at 110˚C did not differ significantly (P< 0.05) from the Ghee clarified at 130˚C. Similarly, the RM value of pure buffalo Ghee clarified at 110˚C did not differ significantly (P< 0.05) from the Ghee clarified at 130˚C. Perusal of the data revealed that temperature of clarification did not affect the Polenske value of Ghee. Results obtained in the present study on Polenske value are in general agreement with those reported by Bector and Narayanan, 1974[9] that clarification temperature did not affect the Polenske value.

Table 11: Polenske value (PV) of cow and buffalo Ghee clarified at 110˚C and 130˚C

Temperature of Clarification	Samples	
	Cow Ghee	Buffalo Ghee
110˚C	1.57±0.030 [a]	1.26±0.016 [a]
130˚C	1.57±0.027 [a]	1.30±0.018 [a]
CD value(P≤0.05)	0.079	0.048

Data presented is mean ± SE of 24 determinations
Values bearing different superscripts in each column differ significantly

Effect of Ripening on Polenske value (PV) of cow and buffalo Ghee

The overall average of Polenske value along with standard error of cow and buffalo Ghee prepared from ripened and fresh cream and clarified at 110˚C and 130˚C are presented in the table 12. Analysis of variance of the data (Table 12) revealed that Polenske value of cow Ghee prepared from ripened cream clarified at 110˚C did not differ significantly (P< 0.05) from the Ghee which was prepared from the fresh cream. Similarly, the Polenske value of cow Ghee prepared from ripened cream clarified at 130˚C did not differ significantly (P< 0.05) from the Polenske value of Ghee prepared from fresh cream and clarified at 130˚C. Similarly, in case of buffalo Ghee no significant difference (P< 0.05) was observed in Polenske value of Ghee prepared from ripened and fresh cream. Therefore, it can be concluded that ripening of cream before the preparation of Ghee did not change the Polenske value of respective Ghee samples significantly.

Table 12: Polenske value (PV) of ripened and fresh cow and buffalo Ghee clarified at 110˚C and 130˚C

Process	Cow Ghee		Buffalo Ghee	
	Temp. of Clarification		Temp. of Clarification	
	110˚C	130˚C	110˚C	130˚C
Unripening	1.59±0.037 [a]	1.53±0.030 [a]	1.24±0.024 [a]	1.28±0.019 [a]
Ripening	1.56±0.049 [a]	1.61±0.045 [a]	1.28±0.023 [a]	1.33±0.032 [a]
CD value(P≤0.05)	0.122	0.107	0.065	0.073

Data presented is mean ± SE of 12 determinations
Values bearing different superscripts in each column differ significantly

Effect of season on Kirschner value of cow Ghee

The average of Kirschner value in different periods of the year of cow and buffalo Ghee clarified at 110˚C and 130˚C are presented in the tables 13 and 14. It can be seen from the table 13 that Kirschner value of cow Ghee clarified at 110˚C was highest in the month of August-September (22.96±0.23) and lowest in month of December-January (21.37±0.09). Analysis of variance of the data (Table 13) revealed that Kirschner value of pure cow Ghee prepared from ripened cream in August-September and October-November differed significantly (P< 0.05) from Kirschner value in December-January and February-March but remained unaffected in period from August-September and October–November. It can also be seen from the table 13 that Kirschner value of cow Ghee prepared from ripened cream and clarified at 130˚C was highest in the month of October–November (22.62±0.11) and lowest in month of December-January (21.22±0.08). Analysis of variance of the data (Table 13) revealed that Kirschner value of cow Ghee differed significantly (P< 0.05) in August-September, October–November and December-January but remained unaffected in February-March when compared to August-September. Perusal of the data revealed that in both the cases i.e. Ghee clarified at 110˚C and 130˚C, the effect of season in Kirschner value was visible. However, Kehar (1956) [10] reported high Kirschner value in winter season and lower in summer season for cow Ghee samples. He attributed this change to the diminution in amount of secretion of butyric acid due to paucity of green fodder in summer.

Table 13: Kirschner value of cow clarified at 110˚C and 130˚C

Temperature of Clarification	Sample Intervals				
	AUG-SEP	OCT-NOV	DEC-JAN	FEB-MAR	CD value (P≤0.05)
Temp-110˚C	22.96±0.23 [a]	22.87±0.06[a]	21.37±0.09[b]	21.59±0.43 [b]	0.663
Temp-130˚C	22.10±0.05 [b]	22.62±0.11[a]	21.22±0.08[c]	22.19±0.07 [b]	0.217

Data presented is mean ± SE of three determinations
Values bearing different superscripts in each row differ significantly

Effect of season on Kirschner value of buffalo Ghee

It can be seen from the table 14 that Kirschner value of buffalo Ghee clarified at 110˚C was highest in the month of August–September (29.34±0.056) and lowest in month of December-January (27.23±0.156). Analysis of variance of the data (Table 14) revealed that Kirschner value of buffalo Ghee differed significantly (P< 0.05) in all months whereas no significant difference in Kirschner value was observed in October–November and February-March. It can also be seen from the table 4.32 that Kirschner value of pure buffalo Ghee clarified at 130˚C was highest in the month of August–September (29.70±0.051) and lowest in month of February-March (28.34±0.021). Analysis of variance of the data (Table 4.32) revealed that Kirschner value of buffalo Ghee differed significantly (P< 0.05) in all months. Perusal of the data also revealed that average Kirschner value of buffalo Ghee was higher than the Kirschner value of cow Ghee (Tables 13 and 14) as buffalo Ghee contained slightly higher amount of butyric acid as compared to cow Ghee (Kehar, 1956) [10].

Table 14: Kirschner value of buffalo Ghee clarified at 110˚C and 130˚C

Temperature of Clarification	Sample Intervals				
	AUG-SEP	OCT-NOV	DEC-JAN	FEB-MAR	CD value (P≤0.05)
Temp-110˚C	29.34±0.056[a]	28.11±0.019[b]	27.23±0.156[c]	28.14±0.122[b]	0.275
Temp-130˚C	29.70±0.051[a]	28.60±0.095[b]	27.41±0.031[c]	28.34±0.021[d]	0.152

Data presented is mean ± SE of three determinations Values bearing different superscripts in each row differ significantly

Effect of temperature of clarification on Kirschner value of cow and buffalo Ghee

The overall average Kirschner value of cow Ghee and pure buffalo Ghee prepared and clarified at 110˚C and 130˚C are presented in the tables 15 and 16. Analysis of variance of the data (Table 15) for Kirschner value revealed that pure cow Ghee clarified at 110˚C did not differed significantly (P< 0.05) from the Ghee clarified at 130˚C. Similarly, the Kirschner value of pure buffalo Ghee clarified at 110˚C did not differ significantly (P< 0.05) from the Ghee clarified at 130˚C. Perusal of the data revealed that temperature of clarification did not affect the Kirschner value of Ghee

Table 15: Kirschner value of cow and buffalo Ghee clarified at 110˚C and 130˚C

Temperature of Clarification	Samples	
	Cow Ghee	Buffalo Ghee
110˚C	21.99±0.169 [a]	28.98±0.421 [a]
130˚C	21.92±0.141 [a]	28.69±0.244 [a]
CD value (P≤0.05)	0.434	0.959

Data presented is mean ± SE of 24 determinations
Values bearing different superscripts in each column differ significantly

Effect of Ripening on Kirschner value of cow and buffalo Ghee

The overall average of Kirschner value along with standard error of cow and buffalo Ghee prepared from ripened and fresh cream and clarified at 110˚C and 130˚C are presented in the table 16. Analysis of variance of the data (Table 16) revealed that Kirschner value of cow Ghee prepared from ripened cream clarified at 110˚C did not differ significantly (P< 0.05) from the Ghee which was prepared from the fresh cream. Similarly, the Kirschner value of cow Ghee prepared from ripened cream clarified at 130˚C did not differ significantly (P< 0.05) from the Kirschner value of Ghee prepared from fresh cream and clarified at 130˚C. Similarly, in case of buffalo Ghee no significant difference (P< 0.05) was observed Kirschner value of Ghee prepared from ripened and fresh cream. Therefore, it can be concluded that ripening of cream before the preparation of Ghee did not change the Kirschner value of respective Ghee samples significantly.

Table 16: Kirschner value of ripened and fresh cow and buffalo Ghee clarified at 110˚C and 130˚C

Process	Cow Ghee		Buffalo Ghee	
	Temp. of Clarification		Temp. of Clarification	
	110˚C	130˚C	110˚C	130˚C
UNRIPENING	21.80±0.238 [a]	21.80±0.241 [a]	29.75±0.774 [a]	28.87±0.434 [a]
RIPENING	22.20±0.244 [a]	22.03±0.163 [a]	28.21±0.239 [a]	28.51±0.258 [a]
CD value (P≤0.05)	0.678	0.577	1.608	1.002

Data presented is mean ± SE of 12 determinations
Values bearing different superscripts in each column differ significantly

Summary & Conclusions

From study, it was found that effect of season was visible in all physico-chemical constants viz. BR reading, RM value, Polenske value and Kirschner value. This may be due to the change in feeding as well as some seasonal variations like heat and humidity, wherein behavior of animals with respect to feed intake and digestion was affected. But ripening of cream and heat clarification temperature did not show any significant affect. The average B.R. reading of cow Ghee was slightly higher than buffalo Ghee as cow Ghee contained higher amount of unsaturated fatty acids and lower amount of saturated fatty acids compared to buffalo Ghee while RM value and Kirschner value of buffalo Ghee was higher than cow Ghee samples as buffalo Ghee contained slightly higher

amount of butyric acid and caproic acid as compared to cow Ghee. The values obtained for different physico-chemical constants were within the limit specified by AGMARK (1981) [11] and FSSR (2011) [12] irrespective of season, ripening of cream and heat clarification temperature.

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