Studies on physico-chemical properties of buffalo milk ghee prepared by using turmeric powder 
(*Curcuma longa* L.)

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Abstract
In the present investigation ghee was prepared by considering treatment combination of buffalo milk and turmeric powder as 99.5%, 99% and 98.5% of buffalo milk and 0.5%, 1% and 1.5% of turmeric powder.

The physico-chemical parameters include moisture, free fatty acid, iodine value, peroxide value, melting point, butyro-refractometer reading were studied. It was observed that as the turmeric powder increase decrease in moisture content, peroxide value, butyro-refractometer reading, free fatty acid of the developed product.

Keywords: Buffalo milk, Ghee, Turmeric powder, physico-chemical properties

Introduction
Plants have been used since ancient times to cure diseases and improve human health (Taher *et al*. 2017) [32]. Herbs and spices come from different parts of the plant are used to impart an aroma and taste to food. Several herbs have therapeutic properties such as antioxidative, anti-inflammatory, anti-diabetic, anti-hypertensive and anti-microbial activities (Samah and Youssef 2019) [26]. Consumption of herbs has significant health promoting effect and reduces the incidence of cardiovascular disease, cancer and various degenerative diseases (Singh *et al*. 2006; Craig 1999; Shishodia *et al*. 2005) [29, 6, 28]. Turmeric has also been used for centuries in Ayurvedic medicine, which integrates the medicinal properties of herbs with food. One tablespoon of turmeric powder contains: 29 calories, 2.1 g of fiber, 0.91 g of protein, 0.31 g of fat, 0.3 g of sugar, 6.31 g of carbohydrates, 26% manganese, 3% Vitamin C, 16% iron, 5% potassium, 2.1 g of fiber, 0.91 g of protein, 0.31 g of fat, 0.3 g of sugar, 6.31 g of carbohydrates, 26% manganese, 3% Vitamin C, 16% iron, 5% potassium. (Khan 2019) [14].

Ghee chemically may be defined as complex lipids of triacylglycerol, together with small quantity of free fatty acids, phospholipids, sterols, hydrocarbons, carbenyl compounds, fat soluble vitamins (A,D, E, and K), carotenoid pigments, moisture and traces of elements like copper and iron. Ghee is also good source of butyric acid, conjugated linoleic acid, phospholipid and fat-soluble vitamins A, D, E and K etc. The present study was proposed to prepared ghee by using turmeric powder having medicinal and nutritional properties and examined its physico-chemical properties.

Materials and Methodology
In the present research work the standard material and methods were used and work was carried out at the Department of Animal Husbandry and Dairy Science, College of Agriculture Latur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

Physico-chemical properties of the product
Physico-chemical parameters like moisture content, free fatty acid, butyro-refractometer reading, iodine value, peroxide value and melting point were examined by adopting standard procedure and data were analyzed statistically by using Completely Randomized Design (CRD) as per Panse and Sukhatme (1985) [21].

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Result and Discussion

Moisture content of turmeric powder added ghee

The data on moisture content in ghee is presented in table 1. It was observed that the average moisture (per cent) of ghee prepared under each treatment was T₁ (0.237), TM₂ (0.218), TM₃ (0.206) and TM₄ (0.195) per cent respectively in 1st stage, in 2nd stage TD₂ (0.215), TD₃ (0.206) and TD₄ (0.195) and in 3rd stage TB₁ (0.189), TB₃ (0.200) and TB₄ (0.210). From the table 1 it is clear that the moisture content of the control (T₁) ghee was 0.237 per cent. As the proportion of the turmeric powder level increased the moisture per cent of ghee decreased. The decreasing trend of moisture from T₂ to T₄ in 1st and 2nd stages may be due to the increased in level of turmeric powder level which expose more hydrophobic nature of turmeric as curcumin is hydrophilic in nature supported by Lodh and Khamrui (2017) [18] . But in third stage the moisture percent was found increased as the turmeric powder increased might be due to the less processing of turmeric occurred due to which the hydrophilic property of turmeric remain sustain or may be increased in combination of milk fatty acids in this case. As Yazadi (2012) [33] stated that curcumin in is hydrophilic in nature and the processing affected on the structural and functional properties of food ingredients. (Fox and McSweeney, 1998) [9].

Table 1: Moisture content in turmeric powder added ghee

| Treatments | Moisture per cent (%) |
|------------|-----------------------|
|            | R-I       | R-II      | R-III     | R-IV      | Mean   |
| T₁         | 0.235     | 0.239     | 0.245     | 0.232     | 0.237  |
| TM₂        | 0.220     | 0.218     | 0.216     | 0.218     | 0.218  |
| TM₃        | 0.209     | 0.205     | 0.204     | 0.207     | 0.206  |
| TM₄        | 0.200     | 0.199     | 0.192     | 0.190     | 0.195  |
| TD₂        | 0.218     | 0.215     | 0.212     | 0.217     | 0.215  |
| TD₃        | 0.208     | 0.202     | 0.206     | 0.208     | 0.206  |
| TD₄        | 0.198     | 0.191     | 0.200     | 0.193     | 0.195  |
| TB₁        | 0.189     | 0.190     | 0.187     | 0.188     | 0.189  |
| TB₃        | 0.200     | 0.207     | 0.197     | 0.198     | 0.200  |
| TB₄        | 0.210     | 0.216     | 0.208     | 0.210     | 0.210  |

The values recorded in moisture content in the present investigation were comparable with below mentioned research. PFA, (2008) [23] as per PFA standards moisture content of ghee should not be more than 0.5%. Sserunjogi et al. (1998) [34] the moisture content of ghee sample varies from 0.17 0.19% among different treatments. Moisture content of ghee is reported to vary from 0.3% maximum. Gupta et al. (1979) [11] reported that 2.5% to 5.0% moisture in ghee offered antioxidant properties. Achaya (1997) [21] storage stability of ghee is attributed to the low moisture content (0.2%). Buch et al. (2014) [24] studied that moisture content in paneer decreased 50.40 (0.4%) and 50.02 (0.6%) with increase in level of turmeric powder in paneer. Paul et al. (2018) [21] prepared paneer by incorporating herbal extract i.e. basil ginger and mint in which moisture content of ginger added paneer decreased 44.88 (T₁) 52.45 (T₂), 52.15 (T₃) and 52.08 (T₄). Prasad et al. (2017) [24] prepared burfi using different herb in which moisture content of turmeric powder added burfi decreased than control 14.68 (control) and 14.38(1%).

Free fatty acid content

The free fatty acid content in turmeric powder added ghee as influenced by different proportions of turmeric powder incorporated in buffalo milk has been presented in table 2.

Table 2: FFA content in turmeric powder added ghee (in per cent)

| Treatments | FFA (per cent) |
|------------|----------------|
|            | R-I | R-II | R-III | R-IV | Mean |
| T₁         | 0.20 | 0.21 | 0.22  | 0.20  | 0.20 |
| TM₂        | 0.18 | 0.20 | 0.21  | 0.19  | 0.19 |
| TM₃        | 0.11 | 0.13 | 0.13  | 0.16  | 0.13 |
| TM₄        | 0.05 | 0.11 | 0.09  | 0.10  | 0.08 |
| TD₂        | 0.19 | 0.17 | 0.18  | 0.20  | 0.17 |
| TD₃        | 0.14 | 0.14 | 0.12  | 0.13  | 0.12 |
| TD₄        | 0.09 | 0.11 | 0.09  | 0.10  | 0.11 |
| TB₂        | 0.09 | 0.05 | 0.08  | 0.07  | 0.10 |
| TB₃        | 0.13 | 0.13 | 0.12  | 0.11  | 0.11 |
| TB₄        | 0.15 | 0.16 | 0.15  | 0.18  | 0.15 |

The data on free fatty acid content in ghee is presented in table 2. It was observed that the average FFA content of ghee prepared under each treatment was T₁ (0.20), TM₂ (0.19), TM₃ (0.13) and TM₄ (0.08) per cent respectively in 1st stage, in 2nd stage TD₂ (0.17), TD₃ (0.12) and TD₄ (0.11) and in 3rd stage TB₂ (0.10), TB₃ (0.11) and TB₄ (0.15). The content of free fatty acid was found decreased as the proportion of turmeric increased indicate that the excess FFA in treated treatments absorb or link with hydrophobic part of turmeric may be curcumin, which showed stronger antioxidant activity in quenching free radicals, Lodh and Khamrui (2017) [18]. This changes in developed treatment may be helpful for enhancement of shelf life of ghee. As the FFA more prone for oxidative rancidity of ghee, might be reduce the possibility in developed treatments. As per the PFA, (2008) [23] standards FFA content of ghee should not be more than 3%. As per the standards and categories of ghee mentioned by AGMARK, according to agmark free fatty acid contains should not be more than 1.4% for special grade ghee, 2.50% for general grade ghee and 3.0% for standard grade ghee, the ghee of present study comes under special grade ghee. Sharma (1981) [27] reported the FFA content of ghee samples varied on an average 0.16 to 0.20% (unripened cream) among different treatments. FFA content of ghee is reported to vary from 0.23 to 0.28.

Lodh and Khamuri (2016) [17] reported initially there was no significant difference in FFA content among the different ghee samples. The initial FFA content of the CFB, CFP, BGB, BGP, CB and CP were 0.204±0.011, 0.200±0.006, 0.200±0.006, and 0.225±0.009%. Naaz and Prakash (2000) [20] studied the traditional method of ghee production with various spices (cardamom, clove, fenugreek, pepper and turmeric) and determine the effect of these spices on keeping quality. FFA value were lowest with these spices on keeping quality. FFA value were lowest with these spices on keeping quality.

Peroxide value

The peroxide value in turmeric powder added ghee as influenced by different proportions of turmeric powder incorporated in buffalo milk has been presented in table 3.
The peroxide value of turmeric powder added ghee of the treatment T1, TM2, TM3 and TM4 in 1st stage were found to be as 0.31, 0.30, 0.29 and 0.27 per cent, respectively. TD2, TD3 and TD4 in 2nd stage were 0.31, 0.30, 0.28 and TB2, TB3 and TB4 in 3rd stage as 0.28, 0.29 and 0.31, respectively. It is clear from above table that the peroxide value of turmeric powder added ghee was positive in first and second stage of addition but observed negative in case of third stage of addition, indicate that the stage of addition of turmeric in food most important to preserve its functionality as well as nutritionally. Mehulkumar and Aparnathi (2011) [19] reported that the addition of curcumin powder at 0.4% gave ghee lower peroxide value as compare to control sample. 1st day of storage in control ghee 0.32 and in turmeric added ghee is 0.32. 3rd day of storage ghee 1.75 and turmeric added ghee is 1.55.

Ghatak and Bandypadhyay (1989) [10] reported peroxide value of 0.2 to 0.7 and 0.6 to 3.10 (mM of O₂/kg) for ghee sample from organized and unorganized sector respectively. The age of samples at the time of analysis was in the range of 1 to 4 months.

Hazra et al. (2015) [12] reported that addition of two variety of tomato skin increase the oxidative stability of ghee during accelerated storage. Peroxide value was lower for tomato added ghee sample as compare to control sample. Naaz and Prakash (2000) [20] studied the traditional method of ghee production with various spices (cardamom, clove, fenugreek, pepper and turmeric) and determine the effect of these spices on keeping quality. Peroxide value 1.39 meq/kg were lowest with turmeric.

Fasludeen (2016) [9] peroxide value was less in pomegranate peel powder 0.908.

Lodh and Khamura (2016) [17] prepared curcumin fortified buffalo ghee in that the initial value of control ghee after 3 day of storage (<0.005). At the end of the six day of storage peroxide value of curcumin fortified buffalo ghee curcumin fortified buffalo ghee (CBF), curcumin fortified buffalo ghee in PE (polyethylene) pouch (CFP), control buffalo ghee in HDPE (high density polyethylene) bottle (CB) and control buffalo ghee in PE pouch (CP) sample were 0.55±0.002, 0.543±0.001. 3.859±0.002 and 3.730±0.003 meq.O₂/kg respectively.

Singh et al. (2014) [30] reported the peroxide values of the paneer varies from 0.486 to 2.38 which shows that the peroxide value increased gradually during the storage.

### Butyro-refractometer reading

The Butyro-refractometer reading in turmeric powder added ghee as influenced by different proportions of turmeric powder incorporated in buffalo milk has been presented in table 4.

### Table 3: Peroxide value in turmeric powder added ghee

| Treatments | R-I | R-II | R-III | R-IV | Mean  |
|------------|-----|------|-------|------|-------|
| T1         | 0.30| 0.32 | 0.31  | 0.31 | 0.31  |
| TM2        | 0.30| 0.31 | 0.31  | 0.30 | 0.30  |
| TM3        | 0.30| 0.31 | 0.29  | 0.30 | 0.29  |
| TM4        | 0.28| 0.28 | 0.27  | 0.28 | 0.27  |
| TD2        | 0.32| 0.31 | 0.30  | 0.32 | 0.31  |
| TD3        | 0.31| 0.30 | 0.29  | 0.30 | 0.30  |
| TD4        | 0.29| 0.28 | 0.27  | 0.29 | 0.28  |
| TB2        | 0.28| 0.29 | 0.28  | 0.28 | 0.28  |
| TB3        | 0.29| 0.31 | 0.29  | 0.29 | 0.29  |
| TB4        | 0.30| 0.32 | 0.32  | 0.31 | 0.31  |

$\text{SE} = \pm 0.00395 \text{ CD at 5\%} = 0.011417$

### Table 4: Butyro-refractometer reading in turmeric powder added ghee

| Treatments | R-I | R-II | R-III | R-IV | Mean  |
|------------|-----|------|-------|------|-------|
| T1         | 41.60| 41.61| 41.52 | 41.50| 41.55 |
| TM2        | 40.40| 40.40| 40.39 | 40.37| 40.39 |
| TM3        | 40.22| 40.26| 40.21 | 40.27| 40.24 |
| TM4        | 40.09| 40.12| 40.10 | 40.14| 40.11 |
| TD2        | 40.42| 40.43| 40.41 | 40.39| 40.41 |
| TD3        | 40.25| 40.25| 40.26 | 40.21| 40.24 |
| TD4        | 40.08| 40.09| 40.15 | 40.17| 40.12 |
| TB2        | 40.56| 40.54| 40.59 | 40.57| 40.56 |
| TB3        | 40.68| 40.71| 40.70 | 40.69| 40.69 |
| TB4        | 40.83| 40.84| 40.88 | 40.80| 40.83 |

$\text{SE} = \pm 0.01507 \text{ CD at 5\%} = 0.043523$
Lodh and Khamurai (2016) \(^{(17)}\) reported butyro-refractometer reading at 40°C in curcumin fortified buffalo ghee is 41.5±0.01. Ramya et al. (2019) \(^{(25)}\) reported average value of BR reading at 40°C in uthukulighee is 40.7±0.04.

### Iodine value

The iodine value in turmeric powder added ghee as influenced by different proportions of turmeric powder incorporated in buffalo milk has been presented in table 5.

The iodine value of turmeric powder added ghee of the treatment T₁, T₂, T₃ and T₄ in 1\(^{st}\) stage were found to be as 31.14, 31.27, 31.35 and 31.44 respectively. T₅, T₆ and T₇ in 2\(^{nd}\) stage 31.22, 31.43, 31.47 and in 3\(^{rd}\) stage 31.32, 31.25 and 31.19, respectively for T₈, T₉ and T₁₀. The pattern for iodine value of turmeric powder added ghee samples were not show fixed trend it was found decreasing in 1\(^{st}\) and 2\(^{nd}\) stage whereas increasing in 3\(^{rd}\) stage of addition of turmeric powder.

| Treatments | R-I (gm) | R-II (gm) | R-III (gm) | R-IV (gm) | Mean (gm) |
|------------|---------|----------|-----------|----------|-----------|
| T₁         | 31.12   | 31.16    | 31.15     | 31.13    | 31.14     |
| T₂         | 31.29   | 31.22    | 31.28     | 31.29    | 31.27     |
| T₃         | 31.35   | 31.36    | 31.32     | 31.37    | 31.35     |
| T₄         | 31.43   | 31.40    | 31.48     | 31.46    | 31.44     |
| T₅         | 31.21   | 31.20    | 31.25     | 31.24    | 31.22     |
| T₆         | 31.34   | 31.31    | 31.38     | 31.35    | 31.34     |
| T₇         | 31.48   | 31.48    | 31.49     | 31.45    | 31.47     |
| T₈         | 31.32   | 31.31    | 31.34     | 31.33    | 31.32     |
| T₉         | 31.25   | 31.27    | 31.26     | 31.23    | 31.25     |
| T₁₀        | 31.18   | 31.20    | 31.20     | 31.19    | 31.19     |

Deshmukh (2018) \(^{(7)}\) reported that the iodine value was small increased with herb extract. Iodine value of control ghee is 35.33 and ashwagandha herb added is 35.48. Lakshminarayana and Murthy (1985) \(^{(16)}\) reported the average iodine value of buffalo ghee is 31.1. Ramya et al. (2019) \(^{(25)}\) reported that the average iodine value of Uthukuli buffalo ghee samples were 27.1±0.74.

### Melting point

The melting point in turmeric powder added ghee as influenced by different proportions of turmeric powder incorporated in buffalo milk has been presented in table 6.

| Treatments | Melting point(ºC) |
|------------|------------------|
|            | R-I              | R-II             | R-III            | R-IV             | Mean |
| T₁         | 32.26            | 32.28            | 32.27            | 32.26            | 32.26 |
| T₂         | 32.31            | 32.33            | 32.32            | 32.34            | 32.32 |
| T₃         | 32.33            | 32.32            | 32.33            | 32.34            | 32.33 |
| T₄         | 32.34            | 32.34            | 32.34            | 32.34            | 32.34 |
| T₅         | 32.29            | 32.28            | 32.30            | 32.29            | 32.29 |
| T₆         | 32.34            | 32.32            | 32.30            | 32.27            | 32.30 |
| T₇         | 32.31            | 32.33            | 32.33            | 32.32            | 32.32 |
| T₈         | 32.40            | 32.34            | 32.36            | 32.35            | 32.36 |
| T₉         | 32.37            | 32.37            | 32.39            | 32.48            | 32.39 |
| T₁₀        | 32.46            | 32.44            | 32.43            | 32.43            | 32.44 |

The melting point of turmeric powder added ghee of the treatment T₁, T₂, T₃ and T₄ in 1\(^{st}\) stage were found to be as 32.26, 32.32, 32.33 and 32.34 respectively. T₅, T₆ and T₇ in 2\(^{nd}\) stage 32.29, 32.30, 32.32 and in 3\(^{rd}\) stage 32.36, 32.39 and 32.44 for T₈, T₉ and T₁₀ respectively. The melting point of turmeric powder added ghee samples were found increased as the turmeric powder increased in the ghee samples might be due to the decreased in FFA in successive treatments of turmeric powder added samples which have liquid or less melting temperature responsible for lowering melting point of developed samples supported by Fox and McSweeney, 1998 \(^{(9)}\) in his book on, “Advanced Dairy Chemistry” volume second on Lipids and following researcher in their respective milk products developed by using turmeric.

Kumar et al., (2015) \(^{(15)}\) reported that nanoencapsulated curcumin ice-cream melts slower (0.83 ±0.01 g/min) than the control ice-cream (0.90± 0.08). Arun Raj et al. (2016) \(^{(4)}\) reported melting point of ashwagandhaghritha is 43°C. Ramya et al. (2019) \(^{(25)}\) reported melting point of the prepared uthukuli buffalo ghee was 33.5±0.61.

### Conclusion

Use of herbs as ayurvedic medicines is a traditional practice in India. Turmeric is a medicinal plant having various health benefits without any side effects. Ghee could absorb all the fat soluble and partially water soluble components from the herbs enhancing their effectiveness. Therefore, it is used as a base material for the preparation of many ayurvedic medicines. The turmeric powder of 0.5%, 1% and 1.5% was added in all

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**Fig 1:** Physico-chemical Properties of Turmeric Powder added Ghee

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three stages. 0.5% is more acceptable than 1.5% added turmeric powder in ghee. It was observed that as the amount of turmeric powder increased, there was increase in iodine value, melting point whereas, deacemoisette content, peroxide value, butyro-refractometer reading, free fatty acidid of ghee.

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