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# Effect of maternal supplementation of seaweed byproducts on nutrient intake and digestibility in advanced pregnant murrah buffaloes

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**Abstract**
The present study was conducted in Livestock Research Centre, National Dairy Research Institute, Karnal Haryana to evaluate the effect of maternal supplementation of seaweed by products (SWBP) on the nutrient intake and digestibility in advanced pregnant Murrah buffaloes. Twelve Murrah buffaloes (~60d prepartum) were assigned to three groups (Control, $T_1$ and $T_2$) with 4 animals each. All the buffaloes were fed basal diet (wheat straw, green fodder and concentrate mixture) as per ICAR, 2013 requirements with additional supplementation of SWBP-1 (*Kappaphycus alverazii and Gracilaria salicornia*) in $T_1$ and SWBP-2 (*Kappaphycus alverazii, Gracilaria salicornia and Turbinaria conoides*) in $T_2$ at 2.5% of concentrate mixture. Supplementation period started from 60d prepartum and continued till calving. A digestibility trial of 7 days was also conducted. Proximate analysis of seaweeds showed that *T. conoides* had highest CP (%) (7.84) followed by *K. alverazii* (5.87) and *G. salicornia* (4.20). Highest TA (%) was found in *G. salicornia* (77.97) and in other two seaweeds the values were comparable. The results revealed that there was no significant ($P$>0.05) difference in DMI (kg/d), CPI (kg/d) and TDNI (kg/d) among the three groups. Digestibility of nutrients (%) was not affected due to supplementation of SWBP. From the present study it can be concluded that maternal supplementation of SWBP did not affect nutrient intake and digestibility in advanced pregnant Murrah buffaloes.

**Keywords:** murrah buffaloes, nutrient intake, seaweed byproducts, SWBP-1, SWBP-2

## Introduction
India has more than 8100 km of coastline that harbours a wide variety of seaweed species. Oza and Zaidi (2001) [21] reported that there are 844 species of seaweeds with 434, 194, and 216 species of red, brown, and green seaweeds, respectively. Coasts of Gujarat and Tamil Nadu are known for their relative abundance of seaweeds (Jha *et al.*, 2009) [3] and are home to 366 seaweed species that account for nearly half of India's total seaweed diversity (Ganesan, 2017) [9]. Around coastal areas of Tamil Nadu, a particular type of seaweed *(Gracilaria edulis)* is being used since decades for making gruel. The composition of seaweeds depends on the species, season, habitat, and prevailing proximate environmental conditions such as desiccation, air and water temperature, light intensity, and nutrient concentrations (Marsham *et al.*, 2007) [15]. Seaweeds are rich in soluble dietary fibres, proteins, minerals, vitamins, antioxidants, phytochemicals, and polyunsaturated fatty acids and have a low caloric value (Mohamed, 2012) [16]. The bioactive substances like polysaccharides, proteins, lipids and polyphenols present in seaweeds have antibacterial, antiviral and antifungal properties (Kumar *et al.*, 2008) [14]. The compounds present in seaweeds exhibit higher water holding capacity than cellulosic (insoluble) fibres. Soluble dietary fibres demonstrate the ability to increase viscosity, form gels and/or act as emulsifiers (Elleuch *et al.*, 2011) [6]. Consumption of seaweed products has recently increased, approximately 15–20 edible algae species being commonly marketed for consumption (Peinado *et al.*, 2014) [21]. In Asia, seaweeds are consumed as a vegetable and on an average, the Japanese eat 1.6 kg seaweed per person per year (Fluerence, 1999) [8]. Seaweeds have been proved to exhibit potent medicinal effects against cancer, allergy, diabetes, oxidative stress, inflammation, thrombosis, obesity, lipidemia, hypertensive and other degenerative ailments (Mohamed, 2012) [16]. Commercially, seaweeds are used as food, ingredients in fertilizers and cosmetics, and in production of agar and alginate (Chan and Phang, 2006) [4]. Green algae contain sulphated galactans and xylans, brown algae are rich in alginic acid, fucoidan (sulphated fucose), laminarin (ß-1, 3 glucan) and sargassan whereas red algae are rich in agars, carrageenans, floridean starch (amylopectin-like glucan), water-soluble sulphated galactan, as well as porphyrin located as

mucopolysaccharides in the intercellular spaces (Murata and Nakazoe, 2001) [18]. Alginic acid present in seaweeds reduces the concentration of cholesterol, prevents the absorption of toxic substances and helps in maintenance of animal and human health by playing an important role as dietary fibre (Nishide and Uchida, 2003) [19]. Global production of seaweeds has been estimated at 30.1 million wet tons in 2016, out of which the culture sector contributes 95% (Ferdouse *et al*., 2018) [7]. The annual standing crop of marine algae of India has been estimated as 3,01,646 tonnes (FAO, 2016). Moreover, seaweeds offer additional advantages, as their cultivation does not compete with terrestrial agriculture, do not need fresh water, and the aquatic photosynthesis contribute to reduce $CO_2$ levels. In India, agar and alginate are produced from seaweeds harvested from wild stocks whereas carrageenan is obtained from cultivated *Kappaphycus alvarezii* (Doty) (Ganesan *et al*., 2019) [10]. Use of seaweeds in animal feeding could also help to alleviate the environmental pollution caused by management of seaweeds in coastal zones. On the other hand, seaweed farming is known to render environmental benefits by recycling nutrients and preventing eutrophication. Thus, there is a huge potential of utilizing these wonder plants of the sea for livestock feeding allowing for improved animal health and performance.

## Material and Method

This study was undertaken at the Animal Nutrition Division, ICAR-NDRI, Karnal to evaluate combinations of seaweed by-products as an agent for maternal programming. Supplementation of seaweed by-products was carried out in pregnant Murrah buffaloes and its effect was studied on their neonatal calves. The details of the experimental procedures employed and methods adopted during the course of study are described briefly here. The experimental protocols carried out in the study were approved by Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) of Ministry of Environment, Forests and Climate Change, Government of India, New Delhi. Procurement of seaweed byproducts were done from Aquagri Processing Private Limited, New Delhi under CSIR sponsored project entitled, "*Kappaphycus alvarezii* and red seaweed-based formulations for improving productivity and health of dairy animals and poultry". Seaweed byproducts of different species were used to make two combinations for supplementation in the diet of pregnant Murrah buffaloes. Pooled samples were analyzed for chemical composition according to standard methods of AOAC (2005) [11]. Fiber fractions were assayed using by procedures of Van Soest *et al*. (1991) [26]. Acid detergent lignin was recovered from ADF by solubilizing cellulose with 72% (w/w) sulphuric acid (Van Soest *et al*., 1991) [26]. Twelve Murrah buffaloes were taken divided in 3 groups, Control (C), T1 and T2 with 4 animals in each group. Control group was fed with basal diet only, T1 with basal diet plus SWBP-1 @2.5% of concentrate mixture and T2 group with basal diet plus SWBP-2 @2.5% of concentrate mixture. All the experimental animals were offered weighed quantity of concentrate mixture once at 09:30 AM and then at 3:30 PM, wheat straw at 9:30 AM and green fodder at 11:00 AM to meet their requirements for maintenance and also for pregnancy (ICAR, 2013) [12]. The amount of feed offered and refusals from all the animals was weighed daily and sampled twice in a week to assess average DM intake throughout the experiment. Clean drinking water was made available daily at 10:00 AM and 04:00 PM. A digestion trial of 7 days collection period was conducted during the experimental period. During the collection period all the animals were offered accurately measured amount of concentrate mixture, jowar fodder and wheat straw and their residues were also measured. Representative samples of feed offered, residues and faeces voided were collected at 24h interval for further sampling in laboratory for analysis and to know the digestibility of nutrients. Intake and digestibility of DM, OM, NDF and ADF were calculated by subtracting faecal loss of these nutrients from intake of these nutrients during digestion trial in each experimental period. Data were analyzed using the general linear models (GLM) procedure of SPSS 16.0 computer package.

## Results and Discussion

### Nutrient composition (% DM basis) used during study trial

Nutrient composition of diet is presented in Table 1. Values for DM, OM, TA, CP, EE, NDF and ADF in sorghum fodder were 31.58%, 89.96%, 10.04%, 6.59%, 1.8%, 61.85% and 28.64% whereas the concentrate mixture contained 89.97% DM, 92.72% OM, 7.28% TA, 18.03% CP, 4.29% EE, 26.28% NDF and 10.84% ADF. These values for wheat straw were 90.17% DM, 89.22% OM, 10.78% TA, 3.07% CP, 1.17% EE, 75.81% NDF and 50.92% ADF.

**Table 1:** Nutrient composition (% DM basis) used during study trial

| Parameter | Wheat Straw | Green fodder (Sorghum) | Concentrate mixture |
|---|---|---|---|
| DM | 90.17±0.13 | 31.58±1.11 | 89.97±0.54 |
| OM | 89.22±0.06 | 89.96±0.46 | 92.72±0.07 |
| TA | 10.78±0.06 | 10.04±0.46 | 7.28±0.07 |
| CP | 3.07±0.05 | 6.59±0.07 | 18.03±0.07 |
| EE | 1.17±0.04 | 1.80±0.09 | 4.29±0.06 |
| NDF | 75.81±0.77 | 61.85±2.59 | 26.28±0.21 |
| ADF | 50.92±0.91 | 28.64±0.12 | 10.84±0.18 |
| Cellulose | 39.78±0.61 | 20.86±0.39 | 3.11±0.12 |
| Hemicellulose | 24.89±1.21 | 33.21±2.65 | 15.4±0.36 |
| Lignin | 6.33±0.16 | 4.38±0.11 | 1.04±0.10 |
| TDN | 46.03±0.29 | 54.87±0.86 | 75.38±0.27 |
| MP | 1.55±0.07 | 4.05±0.03 | 11.20±0.05 |
| ME (Mcal/kg) | 1.51±0.01 | 1.94±0.04 | 2.99±0.01 |

### Chemical composition (% DM basis) of seaweed byproducts and their formulations

The detailed chemical composition of seaweed byproducts and their formulations is presented in Table 2. In *Gracilaria salicornia*, the percentage of DM (95.84), TA (77.97) and AIA (32.46) was highest whereas the percentage of OM

(22.03), CP (4.20) and EE (0.30) was lowest. The percentage of DM, OM, CP, EE, TA, AIA in *Kappaphycus alverazii* and *Turbinaria conoides* ranged from 88.83 to 91.76, 62.12 to 66.81, 5.87 to 7.84, 0.49 to 0.63, 33.19 to 37.88 and 8.80 to 9.53 respectively. Out of the two seaweed byproducts formulations, SWBP-1 had higher percentage of DM (93.80), TA (57.91) and AIA (20.62) whereas SWBP-2 contained higher percentage of OM (50.55) and CP (5.97). Both the seaweed byproduct formulations had similar percentage of EE (0.47). Out of three, red seaweed *Gracilaria salicornia* had the highest NDF and ADF content (35.11 and 15.92% respectively) followed by red seaweed *Kappahycus alverazii* (28.75 and 14.04% respectively) and lowest in *Turbinaria conoides* (25.47 and 10.23% respectively).

Composition of seaweed byproducts found in this study are in accordance with values found by Sharma *et al.* (2020) [223] except that they reported higher values for TA and EE whereas lower values for OM in the seaweed product. Munde (2019) [17] reported similar chemical composition of *Kappaphycus* and *Gracilaria* except that the TA and AIA content of *Gracilaria* found in our study were higher. The composition of seaweeds is highly variable therefore the deviation in chemical composition of seaweed products found by various researchers might be due to varying species, season, habitat and microclimate such as water temperature, light intensity and nutrient concentrations.

**Table 2:** Chemical composition (% DM basis) of seaweed byproducts and their formulations

| Ingredient | DM | OM | TA | CP | EE | NDF | ADF |
|---|---|---|---|---|---|---|---|
| *KA* | 91.76±0.42 | 62.12±0.84 | 37.88±0.84 | 5.87±0.06 | 0.63±0.02 | 28.75±0.09 | 14.04±0.13 |
| *GS* | 95.84±0.53 | 22.03±0.51 | 77.97±0.51 | 4.20±0.06 | 0.30±0.02 | 35.11±0.05 | 15.92±0.17 |
| *TC* | 88.83±0.66 | 66.81±0.78 | 33.19±0.78 | 7.84±0.04 | 0.49±0.03 | 25.47±0.11 | 10.23±0.10 |
| SWBP-1 | 93.80±0.86 | 42.09±0.64 | 57.91±0.64 | 5.04±0.06 | 0.47±0.02 | 31.9±0.02 | 14.92±0.08 |
| SWBP-2 | 92.15±0.49 | 50.55±0.33 | 49.45±0.33 | 5.97±0.08 | 0.47±0.05 | 29.71±0.07 | 13.22±0.06 |

**Body weight of advanced pregnant Murrah buffaloes during study trial**

The data pertaining to body weight of advanced pregnant Murrah buffaloes is presented in Table 3. The initial body weight at 60d pre-partum was similar in all three groups and ranged from 628.9 kg to 656.5 kg with a period mean of 640.9 kg. The body weight of animals remained statistically similar among the treatment groups throughout the study. These results indicate that there was no influence of supplementation of seaweed byproducts on body weight of animals, however, an increase in body weight was found in all the groups as the parturition approached which maybe attributable to weight of calf and products of gestation.

**Table 3:** Body weight of the animals measured during study trial.

| Days prepartum | Control | $T_1$ | $T_2$ |
|---|---|---|---|
| 60d | 637.2±28.87 | 656.5±16.14 | 628.9±37.28 |
| 45d | 648.9±28.86 | 669.7±17.17 | 644.5±38.60 |
| 30d | 663.4±29.15 | 685.8±18.23 | 662.1±40.15 |
| 15d | 680.7±28.91 | 703.7±19.31 | 681.9±41.29 |
| 7d | 699.8±28.50 | 724.0±20.46 | 702.7±41.75 |
| Average | 666.0±12.56 | 687.9±8.94 | 664.0±16.94 |

**Nutrient intake and digestibility in advanced pregnant Murrah buffaloes during digestibility trial**

Average values of nutrient intake and digestibility during the digestibility trial have been given in Table 4. The average DM intake in C, $T_1$ and $T_2$ were 11.21, 11.32 and 10.89 kg/d respectively which when expressed as % of ICAR requirement was 72.62, 71.96 and 70.62 in C, $T_1$ and $T_2$ respectively. Intake of CP in all the groups was found to be 0.94 kg/d whereas DCP intake varied from 0.55 kg/d in C and $T_1$ groups to 0.57 kg/d in $T_2$ group. CP intake expressed in terms of ICAR requirement was 99.55%, 98.38% and 99.46% in C, $T_1$ and $T_2$ groups respectively. The intake of TDN ranged from 6.11 to 6.25 kg/d in different groups which was 105.84% to 107.24% of ICAR requirement. The mean values of DM digestibility were 64.58%, 64.97% and 65.13% in C, $T_1$ and $T_2$ groups respectively. OM digestibility in different groups ranged from 66.57 to 67.62% whereas digestibility of CP varied from 57.91 to 60.08%. Digestibility of EE was 71.62% in C, 72.79% in $T_1$ and 73.48% in $T_2$ group whereas for NDF, it ranged from 57.48 to 58.78% in all groups. ADF digestibility was 49.21%, 49.99% and 51.27% in C, $T_1$ and $T_2$ group whereas in the respective groups, digestibility values for TDN were 54.94, 55.16 and 55.8%.

Statistical analysis of data in Table 4 revealed that nutrient intake and digestibility among treatment groups did not change due to supplementation of seaweed byproducts. It is evident from the data that seaweed byproducts supplementation up to 2.5% of concentrate mixture did not affect the palatability of diet, hence the DM intake remained similar in all the groups. Also, the digestibility of proximate principles and cell wall constituents was not influenced by seaweed byproducts supplementation, leading to similar TDN values in different groups. Antaya *et al.* (2019) [2] reported a quadratic increase in DMI with increased level of seaweed *Ascophyllum nodosum* in the diet. El-Din *et al.* (2008) [5] reported that DM, TDN and DCP intake were significantly ($P<0.05$) higher by calves fed kelp meal than that by control ration and buffer supplemented ration during all experimental periods. The intake as DM, TDN and DCP increased by 6.80, 11.60 and 15.15% during the whole experimental period by calves fed kelp meal compared with those fed control diet, respectively. Our results corroborate with the findings of Sharma *et al.* (2020) [23] and Singh *et al.* (2016) [24] who reported no change in DMI of cows fed with seaweed powder. Spiers *et al.* (2004) [25] reported that feed intake of growing steers did not change when seaweed was supplemented in their diet. Inclusion of brown seaweed at 0.25 and 0.5% DM in the diet of dairy cattle did not affect overall DMI (Pompeu *et al.*, 2011) [22]. In a study by Abdoun *et al.* (2013) [1], seaweed inclusion in the diet of lambs had no effect on daily feed intake. Contrary to our findings, Cabrita *et al.* (2016) [3] reported a decrease in DM intake by 24 and 25% when alfalfa hay was supplemented with *Ulva rigida* and *Gracilaria vermiculophyla* respectively. This might be due to an inclusion level of seaweeds at 20% of diet which is very high as compared to our study.

Supplementation of seaweed byproducts had no effect on digestibility of DM, OM, CP, EE, NDF, ADF and NFC. This indicates that seaweed byproducts when fed at 2.5% of concentrate mixture did not impact nutrient digestibility in animals. Our results coincide with the findings of Antaya *et* *al*. (2019) [2] who reported no change in digestibility of DM, OM, NDF and ADF when diet was supplemented with kelp meal. Similarly, when pigs were supplemented with *Laminaria* seaweed extract, there was no effect on nutrient digestibility (Reilly *et al*., 2008). Munde (2019) [17] found no change in nutrient digestibility in crossbred cattle when seaweed byproducts were supplemented in their diet. In contradiction, Cabrita *et al.* (2016) [3] reported that digestibility of diet containing seaweeds were lower by 4 to 6% than control diet containing no seaweed. In their study, they used 20% inclusion level of seaweeds which may be the main reason for lower digestibility of nutrients.

**Table 4:** Nutrient intake and digestibility in advanced pregnant Murrah buffaloes during digestibility trial

| Nutrient intake | Control | $T_1$ | $T_2$ | P- value | SEM |
|---|---|---|---|---|---|
| DMI (kg/d) | 11.21±0.217 | 11.32±0.078 | 10.89±0.187 | 0.161 | 0.094 |
| DM requirement (kg/d) | 15.44±0.263 | 15.76±0.165 | 15.44±0.303 | 0.528 | 0.137 |
| DMI% of ICAR | 72.62±1.012 | 71.96±0.807 | 70.62±0.451 | 0.228 | 0.464 |
| CPI (kg/d) | 0.94±0.016 | 0.94±0.006 | 0.94±0.015 | 0.995 | 0.007 |
| CP requirement (kg/d) | 0.94±0.008 | 0.95±0.005 | 0.94±0.103 | 0.513 | 0.004 |
| CPI% of ICAR | 99.55±1.165 | 98.38±0.523 | 99.46±0.48 | 0.461 | 0.434 |
| DCPI (kg/d) | 0.55±0.012 | 0.55±0.01 | 0.57±0.021 | 0.495 | 0.008 |
| TDNI (kg/d) | 6.17±0.151 | 6.25±0.09 | 6.11±0.198 | 0.791 | 0.083 |
| TDN requirement (kg/d) | 5.69±0.07 | 5.75±0.04 | 5.83±0.09 | 0.314 | 0.037 |
| TDNI% of ICAR | 107.24±2.302 | 107.24±1.83 | 105.84±2.429 | 0.875 | 1.229 |
| Nutrient digestibility % | | | | | |
| DM | 64.58±0.672 | 64.97±0.83 | 65.13±1.113 | 0.909 | 0.504 |
| OM | 66.57±0.61 | 66.95±0.779 | 67.62±1.135 | 0.705 | 0.491 |
| CP | 57.91±0.646 | 58.39±1.028 | 60.08±1.541 | 0.389 | 0.647 |
| EE | 71.62±0.839 | 72.79±0.605 | 73.48±0.759 | 0.217 | 0.422 |
| NDF | 57.48±0.814 | 58.58±1.098 | 58.78±1.311 | 0.684 | 0.629 |
| ADF | 49.21±1.068 | 49.99±1.206 | 51.37±1.37 | 0.483 | 0.705 |
| NFC | 92.63±0.253 | 90.56±1.204 | 91.86±0.933 | 0.295 | 0.553 |
| TDN% | 54.94±0.568 | 55.16±0.713 | 55.8±1.041 | 0.745 | 0.451 |

## Conclusions
Thus, it can be concluded that supplementation of tropical seaweed byproducts at 2.5% of concentrate mixture in the diet of advanced pregnant Murrah buffaloes did not affect nutrient intake and digestibility.

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## References
1. Abdoun KA, Okab AB, El-Waziry AM, Samara EM, Al-Haidary AA. Dietary supplementation of seaweed (*Ulva lactuca*) to alleviate the impact of heat stress in growing lambs. Pak. Vet. J 2013;34:108-111.
2. Antaya NT, Ghelichkhan M, Pereira ABD, Soder KJ, Brito AF. Production, milk iodine, and nutrient utilization in Jersey cows supplemented with the brown seaweed *Ascophyllum nodosum* (kelp meal) during the grazing season. Journal of dairy science 2019;102(9):8040-8058.
3. Cabrita AR, Maia MR, Oliveira HM, Sousa-Pinto I, Almeida AA, Pinto E *et al*. Tracing seaweeds as mineral sources for farm-animals. Journal of applied phycology 2016;28(5):3135-3150.
4. Chan CX, Ho CL, Phang SM. Trends in seaweed research. Trends in Plant Science 2006;11(4):165-166.
5. El-Din AM, Gaafar HMA, El-Nahas HM, Ragheb EE, Mehrez AF. Effect of natural feed additives on performance of growing Friesian calves. Egyptian J Anim. Prod 2008;45:401-413.
6. Elleuch M, Bedigian D, Roiseux O, Besbes S, Blecker C, Attia H. Dietary fibre and fibre-rich by-products of food processing: Characterization, technological functionality and commercial applications: A review. Food chemistry 2011;124(2):411-421.
7. Ferdouse F, Holdt SL, Smith R, Murúa P, Yang Z. The global status of seaweed production, trade and utilization. Globefish Research Programme 2018;124:1.
8. Fleurence J. Seaweed proteins: biochemical, nutritional aspects and potential uses. Trends in food science & technology 1999;10(1):25-28.
9. Ganesan M, Eswaran K, Reddy CRK. Farming of agarophytes in India—a long-time sustainability for the industry and preserving wild stocks. Journal of Applied Phycology 2017;29(5):2239-2248.
10. Ganesan M, Trivedi N, Gupta V, Madhav SV, Reddy CR, Levine IA. Seaweed resources in India–current status of diversity and cultivation: prospects and challenges. Botanica Marina 2019;62(5):463-482.
11. Horwitz W, Latimer G. AOAC-Association of official analytical chemists. Official Methods of Analysis of AOAC International 18th ed, Gaithersburg, Maryland, USA 2005;45:75-76.
12. ICAR. Nutrient requirements of cattle and buffalo. Nutrient requirements of animals, Indian Council of Agricultural Research, New Delhi 2013.
13. Jha B, Reddy CRK, Thakur MC, Rao MU. Seaweeds of India: the diversity and distribution of seaweeds of Gujarat coast. Springer Science & Business Media 2009, 3.
14. Kumar CS, Ganesan P, Suresh PV, Bhaskar N. Seaweeds as a source of nutritionally beneficial compounds-a review. Journal of Food Science and Technology 2008;45(1):1.
15. Marsham S, Scott GW, Tobin ML. Comparison of nutritive chemistry of a range of temperate seaweeds. Food chemistry 2007;100(4):1331-1336.
16. Mohamed S, Hashim SN, Rahman HA. Seaweeds: a sustainable functional food for complementary and alternative therapy. Trends in Food Science &

Technology 2012;23(2):83-96.
17. Munde VK. Evaluation of seaweed meal as ruminant feed supplement (Doctoral dissertation). ICAR- Indian Veterinary Research Institute, Izatnagar, Bareilly, U.P. (India) 2019.
18. Murata M, Nakazoe JI. Production and use of marine aIgae in Japan. Japan Agricultural Research Quarterly: JARQ 2001;35(4):281-290.
19. Nishide E, Uchida H. Effects of Ulva powder on the ingestion and excretion of cholesterol in rats. In Proceedings of the 17th International Seaweed Symposium, Oxford University Press, Oxford 2003, 165-168.
20. Oza RM, Zaidi SH. A revised checklist of Indian marine algae. CSMCRI, Bhavnagar 2001, 296.
21. Peinado I, Girón J, Koutsidis G, Ames JM. Chemical composition, antioxidant activity and sensory evaluation of five different species of brown edible seaweeds. Food Research International 2014;66:36-44.
22. Pompeu LB, Williams JE, Spiers DE, Weaber RL, Ellersieck MR, Sargent KM *et al.* Effect of Ascophyllum nodosum on alleviation of heat stress in dairy cows. The Professional Animal Scientist 2011;27(3):181-189.
23. Sharma A, Datt C. Supplementation effect of red seaweed powder on dry matter intake, body weight and feed conversion efficiency in crossbred cows. Journal of Entomology and Zoology Studies 2020;8(2):1056-1059.
24. Singh BK, Chopra RC, Rai SN, Verma MP, Mohanta RK. Effect of feeding seaweed as mineral source on mineral metabolism, blood and milk mineral profile in cows. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences 2016;86(1):89-95.
25. Spiers DE, Eichen PA, Leonard MJ, Wax LE, Rottinghaus GE, Williams JE *et al.* Benefit of dietary seaweed (*Ascophyllum nodosum*) extract in reducing heat strain and fescue toxicosis: A comparative evaluation. Journal of Thermal Biology 2004;29(7-8):753-757.
26. Van Soest, PJ van, JAMES B. Robertson, and BA1660498 Lewis. Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to animal nutrition. Journal of dairy science 1991;74(10):3583-3597.