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Effect of vacuum packaging on the physico-chemical and shelf life attributes of herbal paneer spread#

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Abstract

A study was conducted to assess the impact of vacuum packaging during storage for herbal paneer spread. Paneer spread incorporated with Aloevera and Tulsi extract (1% each) was packed and stored in normal and vacuum package (LDPE pouch) at refrigerated temperature (5±1ºc) and analysis were done at 5 days interval. The product was analysed for its Physico-chemical studies and shelf-life attributes were examined during storage by microbial analysis like standard plate count and coliform count. The paneer spread with herbal extract stored in vacuum packaging have more functional properties and shelf-life than normal packaging. The efficiency of vacuum packaging is good by removing more moisture content than normal packaging therefore it increased the shelf life of the herbal paneer spread by 50% (approximately) as compared with normal packaging at refrigerated storage.

Keywords: *Herbal paneer spread, tulsi, aloevera, physico-chemical properties, shelf-life study, vacuum packaging*

India stands first in world milk production with 198.44 million tonnes for the financial year 2019-20 (Ambili *et al*., 2023). The importance of traditional dairy sweets is underlined by the fact that about 50 per cent of India's milk production is utilized for making these products such as Khoa based sweets, concentrated dairy products, Paneer, ghee, Malai, Dahi, Chhana and Chhana based sweets like Rasagolla, Rasmalai, Sandesh, Chhana podo (Singh *et al*. 2009; Ambili *et al*., 2023). "Let food be your medicine and medicine be your food" was a tenet espoused by

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Hippocrates in approximately 400 B.C. "Food as medicine" philosophy that is the core of functional foods (Singh *et al*., 2018). The rapid growing population in the developing countries is facing acute shortage of protein in diet, which inadvertently has led to an increase in the instances of malnutrition (Ur-Rehman *et al.,* 2007; Singh *et al*., 2016).

Now, health-conscious consumers in India prefers the functional foods and one of the major trends in India's food market is the addition of herbs/herbal ex-tract and novel functional ingredients into traditional dairy products through up-gradation of technology (Gawande *et al.* 2012; Ambili *et al*., 2023). Herbs like aloevera and tulsi are the plants being used by humans from ancient times. There are arrays of naturally occurring medicinal herbs that have functions in regulation of blood pressure and sugar level by stimulating physiological system in humans. It is reported to exhibit antimicrobial, anti-inflammatory, antifungal, antioxidant, antiseptic and cosmetic values for health care (Jadhav *et al*., 2020). Tulsi (*Ocimum sanctum* L.) has been used for thousands of years in Ayurveda for its diverse healing and medicinal properties. Garlic and pepper are commonly used spices that are used singly or combined in various diets all around the world and there is a long-held belief of their therapeutic properties. Garlic is found to reduce cholesterol, improve heart health and reduce blood pressure. Pepper is found to reduce appetite, increase fat burning (weight management) and also effective in combating lung, liver and prostate cancer (El-Sayed and Youssef, 2019).

Paneer is an indigenous variety of heat and acid coagulated product obtained by entrapping almost all the fat, casein (complexed with denatured whey proteins) and portion of entrapped salts and lactose. Paneer is popular among Indian population. The advantage of paneer consumption is low fat content as compared to butter and cheese spread; it can be consumed by any age group (Kanwar *et al.,* 2021). A healthy spread based on paneer curd with additive like aloevera, tulsi, garlic and pepper would be liked by all age groups due to its immense health benefits. Vacuum packaging is an effective packaging technology that removes air from the product pouch and hermetically sealing it by applying some pressure, which increases the shelf-life by inhibiting the microbial growth and reducing the risk of cross contamination (Meena *et al.,* 2017).

Hence, an alternative to butter and cheese spread, herbal paneer spread was developed as a suitable alternative to other dairy spreads available in the markets which could be further flavoured with other herbs/spices and fruits that play multifarious role. The objective of the present investigation was to evaluate the shelf-life attributes of herbal paneer spread under vacuum package and also to assess the changes taken place in physico-chemical and microbiological attributes during storage.

Materials and methods

The study was carried out in the Dairy Technology Department, Verghese Kurien Institute of Dairy and Food Technology, Kerala Veterinary and Animal Sciences University, Mannuthy, Thrissur.

Raw materials

Cow milk as the base material for Paneer spread was procured from Kerala Veterinary and Animal Sciences University Dairy plant, Thrissur. Herbs (fresh leaves) like aloevera (Aloe barbadense miller) and tulsi (*Ocimum sanctum* L.) were collected from the local premises, washed thoroughly and extracted for the study. Garlic (*Allium sativum*), Black pepper (*Piper nigrum*) and salt were procured from the local market Mannuthy, Thrissur, Kerala.

Manufacture of herbal paneer spread

The method suggested by Rajeswari (2021) was adopted with slight modification to make herbal paneer spread (Fig. 1).

Physico-chemical analysis

Moisture content of herbal paneer spread was determined according to AOAC (2000). The total soluble solids content of herbal paneer spread was determined by the method

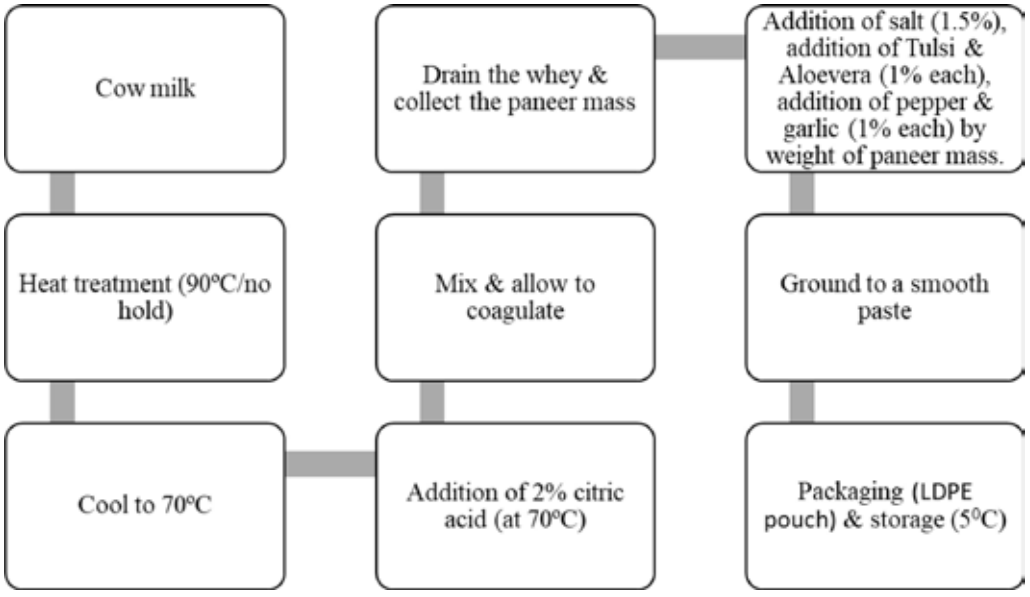

Fig. 1. Flow chart representing the preparation of Herbal paneer spread

recommended in IS: 1224: Part I and Part II (1981). The titratable acidity was determined by the method recommended by IS: SP:18, 1981. The fat content was determined according to the method described in IS: 1224: Part I (1977). The ash content was determined according to the method described in IS 1479-2 (1961): Part II. The FFA content of herbal paneer spread samples was determined by extraction titration method suggested by Deeth *et al.* (1975). The total nitrogen content was determined by Micro Kjeldahl method (AOAC, 2000). Antioxidant activity of herbal paneer spreadwas measured using the method suggested by Brand *et al*. (1995) with minor modifications.

Shelf-life study

Shelf-life study of herbal paneer spread was assessed for Aerobic Plate Count and coliform count by pour plate methods described by IS 5402:2002/ ISO: 4833:1991 reaffirmed in 2007 and IS 5401(Part 1): 2002/ ISO 4832:1991 reaffirmed 2007, respectively.

Statistical analysis

The Statistical evaluation of the data obtained was done by the analysis of variance (Snedecor and Cochran, 1989) using SPSS software version 22.

Results and discussion

Effect on moisture

The moisture content (Fig. 2) in herbal paneer spread under normal packaging was 60.4% on 0th day and gradually decreasing for normal packaging to 50.7% within 10th day and then after product got spoiled. But, for vacuum packaging, the moisture content was decreased slowly to 51.6% with the refrigerated storage period within 15 days and then after product got spoiled at 15th day.

For control (paneer spread), the moisture content was 58% on 0th day and gradually decreased for normal packaging to 46.1 within 10 days of refrigerated storage and spoiled at 10th day. Whereas for vacuum packaging (control), the moisture content was decreased slowly with the refrigerated storage period to 45.7 within 15 days of refrigerated storage and spoiled at 15th day. The moisture content in herbal paneer spread had higher value than control due to the addition of herbal extract. The results showed that the vacuum packaging treated samples had more moisture content than normal packaging during storage for 10th and 15th day, which, indicates that the vacuum products had less moisture loss during storage, hence, the freshness of the product

was maintained. Similar to our findings, Verma *et al.* (2007) reported lower moisture loss for paneer *tikka* at refrigeration temperature under modified atmosphere packaging.

Effect on total soluble solids

The total solid content in herbal paneer spread and control gradually increased from the initial value (Fig. 3). The total solids content in control was higher than treatment (herbal paneer spread) under both the packaging techniques. The total solids and moisture contents were inter-related to each other, A decrease in moisture content during storage indicates an increase in total soluble solids. This result indicated that the nutrients, that might have otherwise lost during storage, were preserved. These results were in confirmation with findings of Rajeswari (2021) and Sharma *et al*. (1998).

Effect on titratable acidity

The acidity of herbal paneer spread and control gradually increased from the initial value. The acidity of herbal paneer spread was 0.81% on 0th day and it increased to 0.90 % up to 15 days at refrigerated storage under vacuum packaging and spoiled at 15th day, whereas, in the case of normal packaging, the acidity of herbal paneer spread increased to 1.3% up to 10 days of refrigerated storage and spoiled at 10th day (Fig. 4). The acidity of control samples under vacuum packaging was 0.87 at 0th day and it increased to 1.52 within 15 days of refrigerated storage and spoiled at 15th day, whereas, the acidity of control with normal packaging was increased to 1.43 within 10 days of refrigerated storage and spoiled at 10th day. These results indicated that vacuum packaging treated samples could be stored for longer time under refrigeration temperature than normal packaged samples. It means the initial freshness of the samples under vacuum treated packaging system was preserved for longer time. Similar to our findings Rajeswari (2021), Ahuja and Goyal (2013) and Verma *et al.* (2007) also observed an increase in titratable acidity (TA) of herbal paneer spread, vacuum packed paneer tikka and modified atmosphere packed paneer tikka, respectively, during refrigerated storage condition.

Effect on fat

The fat content of herbal paneer spread and control at 0th day was 24.7% and 24.3%, respectively, it gradually increased to 25.2% and 24.8% up to 15 days of storage for respective product. The fat content in vacuum packed and normal packed product was found to be 25.3% and 25% at 10 days of storage and on 15th day visible spoilage was detected and thus product was unfit for consumption (Fig. 5). These results were in confirmation with the findings of Sharma *et al*. (1998) and Rajeswari (2021).

Table 1. Total microbial count and coliform count found in normal packaging

Sample	Days of storage			
	0th	5th	10th	15th
SPC (@10^3)				
Control	2.69^a	3.184^x	numerous count	spoiled
Product	2.39^a	2.763^y	numerous count	spoiled
t value	-	28.4**	-	-
Coliforms (@10^1)				
Control	Absent	Absent	7^{ns}	spoiled
Product	Absent	Absent	8^{ns}	spoiled
t value	-	-	9.1**	-

*All values are mean +/- standard deviation of 3 independent replications, similar values in superscript showed non-significant ** significant at one per cent level (p<0.01), ns- non-significant (p≥0.05)

Table 2. Total microbial count and coliform count found in vacuum packaging

Sample	Days of storage			
	0^{th}	5^{th}	10^{th}	15^{th}
SPC (@10^3)				
Control	2.69^{a}	3.13^{xb}	3.17^{xc}	numerous count
Product	2.39^{a}	2.56^{yb}	2.71^{xb}	numerous count
t value	-	10.95**	2.06ns	-
Coliforms (@10^1)				
Control	Absent	Absent	Absent	5^{ns}
Product	Absent	Absent	Absent	6^{ns}
t value	-	-	-	6.7**

*All values are mean +/- standard deviation of 3 independent replications, similar values in superscript showed non-significant **significant at one per cent level ($p<0.01$), ns- non-significant ($p\geq0.05$)

Effect on ash content

The total ash content of herbal paneer spread was 1.16% on 0^{th} day and it gradually increased to 2.5% for vacuum packaging within 15 days of storage as well as ash content steadily increased to 17% for normal packaging. The ash content of control was 1.13% on 0^{th} day and it gradually increased to 1.16% within 15 days of storage and for vacuum packaging as well as ash content gradually increased to 0.92% within 10 days of storage for normal packaging (Fig. 6). Similar findings were also suggested by Ahuja and Goyal (2013) and Rajeswari (2021) who observed the ash content in vacuum packed paneer tikka and herbal paneer spread, respectively.

Effect on free fatty acid content

The free fatty acid content for both products (herbal paneer spread and paneer spread) were increased during refrigerated storage (5±1ºC). It was found that there was a gradual increase in free fatty acid value under vacuum packed herbal paneer spread and paneer spread (control) as compared with normal packaging of same products (Fig. 7). The gradual increase in FFA value for vacuum packed products may be due to the preserving property of vacuum package. In confirmation to our findings, Andic *et al.* (2011) observed that vacuum packaging help to preserve Motal cheese characteristics when it is stored at refrigeration temperature.

Protein

The protein content for herbal paneer spread and control gradually decreased with refrigerated storage (5±1ºc). The protein content of herbal paneer spread and control was 21.66% and 16.63%, respectively, at the 0^{th} day under vacuum packaged (Fig. 8). The results indicated that protein content of herbal paneer spread under vacuum decreased slowly as compared with control sample of normal packaging. This may be due to the effect of vacuum packaging. Similar findings were also suggested by Verma *et al.* (2007), Rajeswari (2021) and Ahuja and Goyal (2013) who also observed an increase in titratable acidity (TA) of modified atmosphere packed paneer tikka, herbal paneer spread, and vacuum-packed paneer tikka, respectively.

Effect on Antioxidant

The free radical scavenging activity of the sample was determined based on the stable free radical (DPPH) with antioxidant component in the media resulting in the bleaching of the DPPH due to its quenching by the interaction with the analytes. The result obtained from spectrophotometric analysis of the control and herbal paneer spread during storage are given in the Fig. (9). Herbal paneer spread had higher antioxidant score than control paneer spread which may be due to presence of herbs. Similar to our findings, Husain and David (2018) also reported that herbal sandesh incorporated with

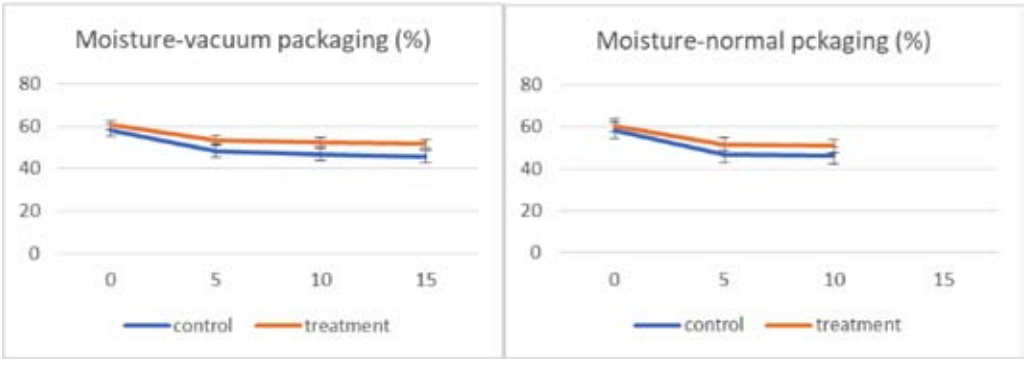

Fig. 1. Moisture composition of herbal paneer spread and control during storage

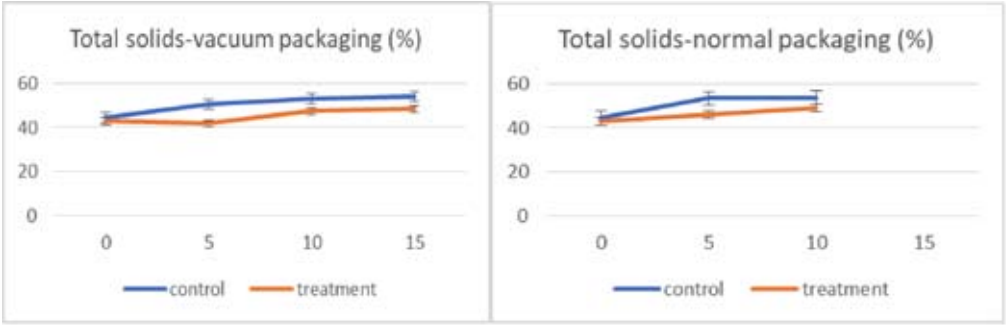

Fig. 2. Total soluble solid content of herbal paneer spread and control during storage

ashwagandha (*Withania somnifera*) and Tulsi (*Ocimum sanctum*) scored higher antioxidant activity than control.

Total microbial count

Total microbial count of herbal paneer spread and paneer spread (control) were analysed by pour plate technique. The number of colonies forming units (cfu) per milli litters (ml) of herbal paneer spread and control packed in LDPE pouch (normal package) and LDPE pouch (vacuum packed) were presented in the table 1 and table 2, respectively. Coliform count was found 7 (x 10^1 cfu/g) and 8 (x 10^1 cfu/g) for control and product, respectively, under normal package. Under vacuum package, the coliform count was recorded 5(x 10^1 cfu/g) and 6 (x 10^1 cfu/g) for control and product, respectively (Table 2).

There was significant increase in total microbial count of control samples (3.18) than herbal paneer spread (2.763) packed in LDPE pouches (normal packaging) during refrigerated storage on 5th day (Table 1), which inferred that the addition of herbs and spices provide anti-microbial effect and therefore increased the shelf life of the product.

Total microbial count for herbal paneer spread and control samples packed under vacuum packaging indicated that the product had a higher shelf life (15th day; table 2) than packed in normal packaging (10th day). It was found that there was a significant increase in SPC count of control samples (3.17) than herbal paneer spread (2.71) packed in LDPE pouches (vacuum packed) during refrigerated storage on 10th day, which inferred that the vacuum packaging enhances the shelf life for both the product. It was also observed that the coliform count was higher in herbal paneer spread than control under both the package during storage which may be due to addition of herbal extract. Similar to our findings, Verma *et al.* (2007), Andic *et al.* (2011) and Ahuja and Goyal (2013) also reported similar results for vacuum packaged paneer tikka, vacuum packaged Motal cheese, and modified atmosphere packaged paneer tikka, respectively, at refrigeration temperature.

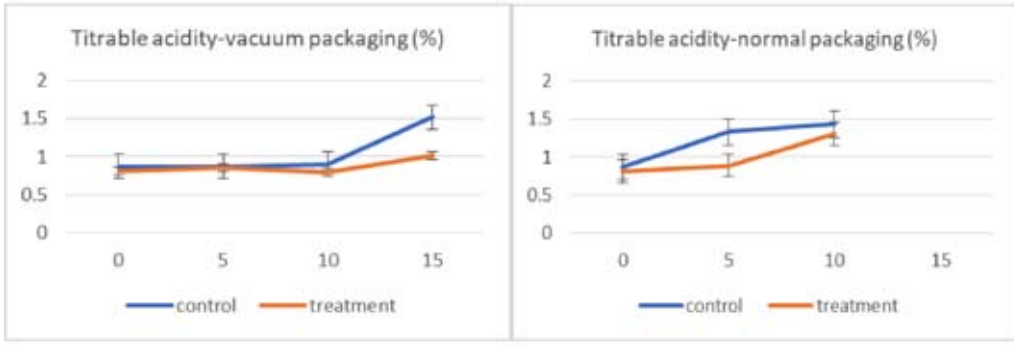

Fig. 3. Titrable acidity of herbal paneer spread and control during storage

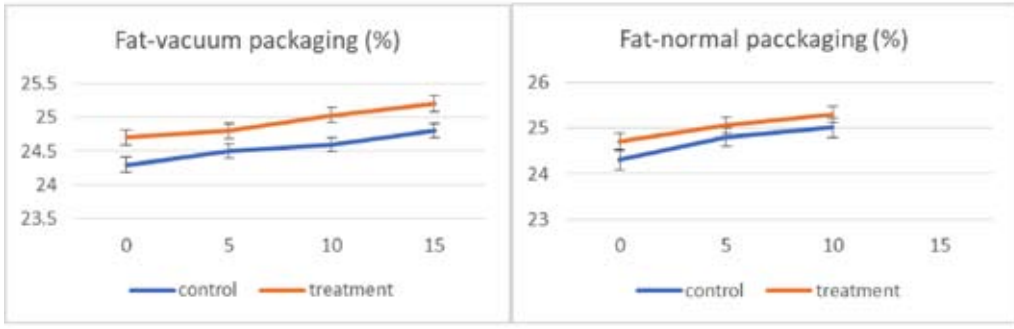

Fig. 4. Fat content of herbal paneer spread and control during storage

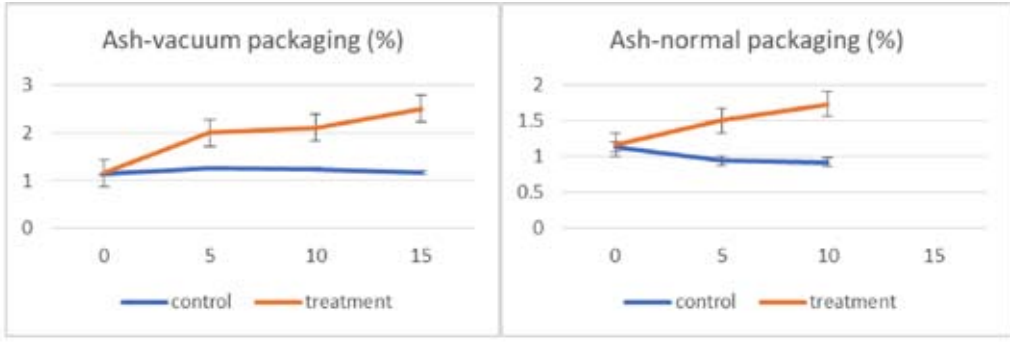

Fig. 5. Ash content of herbal paneer spread and control during storage

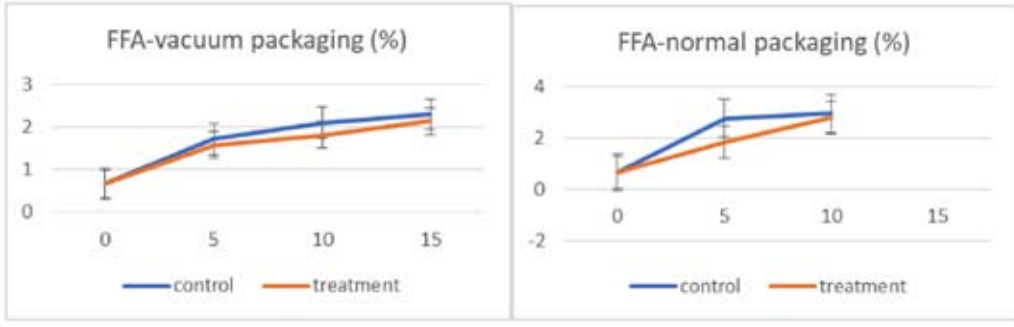

Fig.6. Free fatty acid content of herbal paneer spread and control during storage

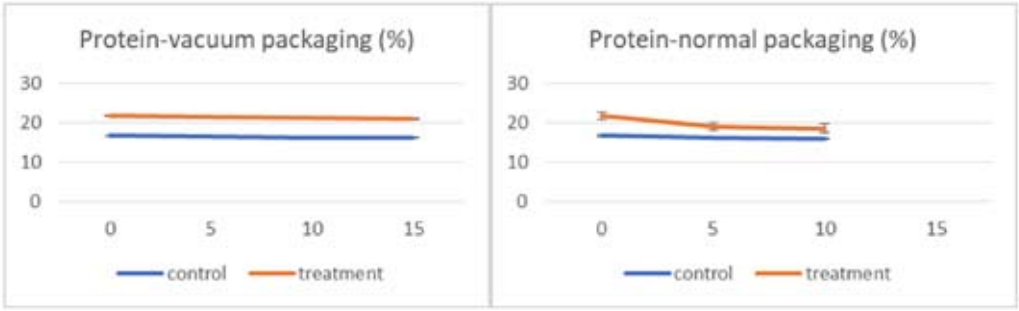

Fig.7. Protein content of herbal paneer spread and control during storage

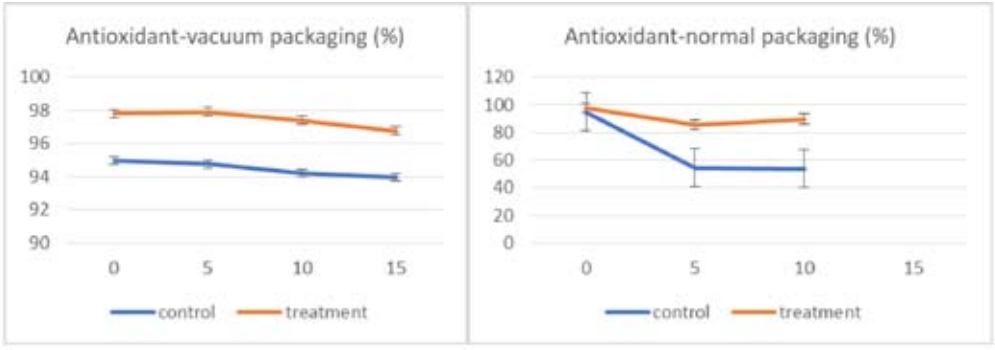

Fig.8. Antioxidant content of herbal paneer spread and control during storage

Conclusion

The herbal paneer spread incorporated with Aloevera and Tulsi extract (1% each) had higher antioxidant activity (96.76±0.6%) than control (93.96±0.4%) for vacuum package on 15th days of refrigeration storage. The protein, fat and ash/ mineral content on 15th day for herbal paneer spread was reported 21.03±0.2%, 25.2±0.2% and 2.5±0.2 %, respectively, which was higher than control. The titratable acidity for control samples under vacuum packaging was 1.52 (%LA) on 15th days of refrigerated storage, while, titratable acidity for normal packaging was found 1.43 (%LA) on 10th days of refrigerated storage and then the product got visible spoilage under normal package which means unfit for consumption. It was found that there was a significant decrease in total microbial count of herbal paneer spread (2.71) than control samples (3.17) during refrigerated storage on 10th day under vacuum packed, which inferred that the vacuum packaging enhances the shelf life of the product. The shelf life of control and herbal paneer spread under normal package was 10 days as visible spoilage was detected on 15th day, while, the shelf life under vacuum packed was 15 days for both the samples. On the basis of physico-chemical and shelf life attributes of herbal paneer spread packed under vacuum and normal condition, it could be concluded that application of vacuum packaging was best suited for extending the shelf life of herbal paneer spread as compared with normal packaging.

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Conflict of interest

The authors declare that they have no conflict of interest.

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