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MIGRATION AND STORAGE STUDIES OF BISCUITS AND CHIPS ON BIODEGRADABLE PACKAGING FILM

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Abstract–The overall migration constituents from a Biodegradable film (LDPE and Cassava starch) into food products (Biscuit and Chips) was studied using 3% aqueous acetic acid (Simulant B). Test conditions as mentioned in IS-9845:1998 of BIS were followed for migration studies and AOAC for Physico-chemical properties and migration. The migration study of biscuits and chips was determined using simulant B. The products were stored at ambient temperature and Physico-chemical properties were evaluated for six months. Overall migration values for biscuits were found to be in the range of 0.29- 0.43 mg/dm^2 and of chips were 0.28-0.42 mg/dm^2. The moisture content of Biscuits and Chips were 1.14%-1.8%, 1.25%-1.77% respectively, Acid value of biscuit and chips was 1.59-2.47%, 1.21-1.99%, Peroxide value of biscuit and chips was 3.91-5.70 mg/g, 3.93-5.47 mg/g. The Free fatty acid of biscuits and chips was 0.79-1.24%, 0.60-1.00% respectively. The migration study result revealed that the biodegradable packaging material was found suitable for packaging biscuits and chips.

INTRODUCTION

Plastics are being used tremendously as food packaging materials in various forms and shapes. Each plastic has its unique properties for its application in food packaging applications. In general plastics used in food contact applications are Low density polyethylene (LDPE), High density polyethylene (HDPE), Polypropylene (PP), Polyethylene terephthalate (PET), and Polystyrene (PS). Such versatile use of plastics is due to a host of advantageous properties like light weight, strength, flexibility, barrier properties towards moisture, flavour and gasses, crack resistance, availability in attractive shapes and sizes and low cost. Plastics are not an inert material and are able to interact with the surrounding environment, allowing food-packaging interactions, such as sorption, permeation and migration. Migrations of additives from packaging materials into foods have been major concern in recent years worldwide. Migration of such additives needs to be controlled for their limits. Plastics polymers are evaluated for their food compatibility by overall/specific migration of additives, using food simulants and simulating test conditions of time and temperature. For the compatibility studies, various international standards have specified different test conditions of time and temperature, based on types of food, coming in contact and used for filling and storing conditions. Different countries, have laid down different specifications like USFDA, EEC, and BIS for their safe use in food contact stimulants such as distilled water (aqueous foods pH ≥5), 3% acetic acid (acidic beverages pH≤5), 10-50% ethanol (alcoholic beverages) and n-heptane (oils/fats and fatty foods). For aqueous food,BIS have specified distilled water and 3% acetic acid use as simulant B. BIS regulation introduces separate sets of standardized testing conditions for overall migration test by using 3% acetic acid for biscuits and chips instead of distilled water (Satish *et al.,* 2013). Hence, the current study was aimed to evaluate the migration from biodegradable packaging material into food product and the physico-chemical changes in that food product (Biscuits and chips) during 180 storage days.

MATERIALS AND METHODS

The experiments were conducted at the Department of Food Process Engineering, Vaugh Institute of Agricultural Engineering and Technology, Prayagraj. For this purpose Biodegradable film blend of (LDPE and Cassava Starch) was taken (T_0-100:0, T_1-95:5, T_2-90:10, T_3-85:15 and T_4-80:20). For Overall migration T_0, T_1, T_2, T_3 and T_4 treatment with food simulant B was used and for storage stability Biscuit and Chips packed in Biodegradable film for six months. The overall migration study and physico-chemical properties like Moisture content, acid value, Peroxide value and free fatty acid of product were determined during the storage period of 180 days according to AOAC(1989) method. The overall migration study of biodegradable packaging film was conducted according to the BIS standards.

RESULTS AND DISCUSSION

Migration is the process in which additives from packaging material is transferred to foodstuff when they are in contact. Migration has been considered as a negative issue since the components contaminate food product and pose threat to human health. However the safe limit of migrant should be followed for safety of humans.

Migration Study

In this migration study, the overall migration from biodegradable film prepared from blend of Cassava starch and LDPE was evaluated. The results of the overall migration in food simulants B were studied. Table 1 shows the overall migration study of biodegradable film with food products biscuit and chips. As per BIS (IS-9845:1998) the overall migration level is not to exceed 0.43 mg/dm^2 in all the treatments. The overall migration level in all treatment varied from day 30 to day 180 for T_0-T_4 (0.29-0.43 mg/dm^2) for but for T_1 sample the migrant value change was less. Similar results were obtained by Satish *et al.,* (2013). During the storage period of 180 days the overall migration level increased within the permissible limit. The range of overall migration for chips varied from (0.28-0.42 mg/dm^2). This result was in agreement with (Alin *et al.,* 2012).

Physico-chemical Properties

The physico-chemical properties are shown in Table numbers 2-5.

Moisture Content

From Table 2 it is evident that moisture content of biscuits and potato chips increased during storage. The increase in moisture content was less for 90 days of storage and continued to increase during remaining storage period. The initial moisture content of biscuit was 1.14% (wb) and after 180 days of storage it was 1.50% and 1.87% (wb). Biscuit packed in T_1 exhibited minimum increase of moisture content (1.14% - 1.55%) and maximum increase was observed in T_4 (1.30% - 1.87%). The initial moisture content of potato chips was 1.25% wet basis (wb) and after 180 days of storage it ranged between 1.48 % to 1.77 % (wb). Potato chips packaged in the T_1 exhibited minimum increase of moisture content 1.25 % and the maximum increase was observed in T_4 (1.77 %). Similar results were obtained by (Nawaz *et al.,* 2021).

Table 1. Effect of different treatments on overall migration studies (mg/dm^2) of biodegradable film with Biscuit and Chips during storage

Storage (d)	Sample	Treatments				
		T_0	T_1	T_2	T_3	T_4
30	Biscuit	0.29±0.12	0.29±0.19	0.30±0.23	0.30±0.12	0.30±0.25
	Chips	0.28±0.24	0.28±0.20	0.29±0.29	0.29±0.01	0.29±0.24
60	Biscuit	0.29±0.11	0.29±0.23	0.30±0.36	0.30±0.13	0.30±0.26
	Chips	0.28±0.32	0.28±0.21	0.29±0.28	0.29±0.23	0.29±0.27
90	Biscuit	0.30±0.25	0.30±0.24	0.31±0.35	0.32±0.36	0.32±0.31
	Chips	0.29±0.24	0.30±0.27	0.30±0.30	0.31±0.25	0.31±0.36
120	Biscuit	0.31±0.23	0.31±0.26	0.32±0.31	0.33±0.24	0.33±0.34
	Chips	0.30±0.12	0.30±0.35	0.31±0.36	0.32±0.36	0.32±0.32
150	Biscuit	0.33±0.23	0.34±0.24	0.35±0.34	0.36±0.28	0.37±0.31
	Chips	0.32±0.33	0.33±0.26	0.35±0.33	0.37±0.29	0.38±0.30
180	Biscuit	0.35±0.55	0.36±0.10	0.38±0.32	0.40±0.15	0.43±0.30
	Chips	0.36±0.38	0.37±0.09	0.39±0.28	0.40±0.14	0.42±0.29

Acid Value

From Table 3 it is evident that Acid value of biscuits and potato chips increased during storage. The acid value was a measure of total acidity of the lipid, involving contributions from all the constituent fatty acids that make up the glyceride molecule. The average acid value of biscuit was (1.69%- 2.47%) and in chips was (1.21%-1.99%) respectively. The noteworthy increase in acid value during six months may have been due to increases in moisture content during storage which promoted fat hydrolysis. Similarly results were obtained by (Nattra *et al.,* 2015).

Free Fatty Acid

From the Table 4 it is evident that Free Fatty value of biscuit and potato chips during storage. The initial free fatty acid of biscuit was 0.84 % and it ranged from (0.95 % to 1.24 %) at the end of the storage period. The free fatty acid values were above the standard values for the period of six months in the control biscuit (0.91%-1.10%) (Jayalaxmi *et al.,* 2018). The increase in FFA content was minimum in the T_1(0.74 %) and maximum in T4(1.24 %). The initial FFA of potato chips was 0.60 % and it ranged from (0.78% to 1.00 %) at the end of the storage period. The variation in FFA content might be due to the hydrolysis and oxidation of oil component in the potato chips (Manikantan *et al.,* 2012). The increase in FFA content was minimum in the T_1 (0.60%-0.78 %) and maximum in T_4(0.78%– 1.00%). The increased FFA in treatment T_4 might be due to higher moisture content 1.77% of potato chips.

Peroxide Value

Peroxide value is one of the most widely used tests for oxidative rancidity in oils and shown in Table 5. It is a measure of the concentration of peroxides and

Table 2. Effect of different treatments on moisture content (% wet basis) of Biscuit and Chips with biodegradable film during storage

Storage (d)	Sample	Treatments				
		T_0	T_1	T_2	T_3	T_4
30	Biscuit	1.19±0.02	1.14±0.36	1.27±0.25	1.27±0.25	1.30±0.14
	Chips	1.25±0.12	1.25±0.33	1.28±0.35	1.34±0.36	1.42±0.13
60	Biscuit	1.22±0.15	1.24±0.24	1.25±0.14	1.30±0.24	1.32±0.25
	Chips	1.28±0.17	1.26±0.25	1.35±0.16	1.39±0.28	1.46±0.14
90	Biscuit	1.29±0.19	1.28±0.14	1.29±0.17	1.30±0.29	1.39±0.26
	Chips	1.30±0.20	1.27±0.16	1.36±0.18	1.42±0.24	1.47±0.27
120	Biscuit	1.31±0.23	1.31±0.17	1.35±0.18	1.39±0.26	1.44±0.28
	Chips	1.32±0.23	1.30±0.15	1.41±0.25	1.46±0.25	1.48±0.36
150	Biscuit	1.38±0.13	1.34±0.15	1.41±0.24	1.44±0.26	1.54±0.21
	Chips	1.33±0.26	1.37±0.16	1.43±0.26	1.47±0.24	1.57±0.14
180	Biscuit	1.50±0.26	1.55±0.14	1.70±0.24	1.68±0.24	1.87±0.18
	Chips	1.48±0.14	1.55±0.16	1.60±0.26	1.74±0.26	1.77±0.19

Table 3. Effect of different treatments on acid value (%) of Biscuit and Chips with biodegradable film during storage

Storage (d)	Sample	Treatments				
		T_0	T_1	T_2	T_3	T_4
30	Biscuit	1.82±0.36	1.69±0.21	1.59±0.15	1.77±0.45	2.02±0.12
	Chips	1.21±0.25	1.21±0.22	1.45±0.25	1.43±0.12	1.57±0.05
60	Biscuit	1.83±0.24	1.60±0.21	1.70±0.12	1.78±0.13	2.02±0.16
	Chips	1.22±0.26	1.22±0.16	1.46±0.21	1.45±0.14	1.59±0.14
90	Biscuit	1.84±0.21	1.61±0.21	1.71±0.23	1.79±0.17	2.03±0.13
	Chips	1.24±0.21	1.24±0.14	1.47±0.24	1.46±0.19	1.60±0.11
120	Biscuit	1.85±0.13	1.62±0.25	1.74±0.28	1.84±0.20	2.06±0.10
	Chips	1.30±0.16	1.30±0.26	1.51±0.14	1.53±0.23	1.64±0.25
150	Biscuit	1.92±0.14	1.73±0.27	1.81±0.16	1.91±0.21	2.11±0.26
	Chips	1.41±0.15	1.42±0.28	1.61±0.19	1.66±0.21	1.73±0.29
180	Biscuit	2.19±0.15	1.90±0.24	2.23±0.20	2.38±0.22	2.47±0.30
	Chips	1.65±0.12	1.56±0.28	1.77±0.17	1.82±0.30	1.90±0.31

Table 4. Effect of different treatments on free fatty acid (%) of Biscuit and Chips with biodegradable film during storage

Storage (d)	Sample	Treatments				
		T_0	T_1	T_2	T_3	T_4
30	Biscuit	0.91±0.12	0.84±0.23	0.79±0.35	0.88±0.25	1.01±0.13
	Chips	0.60±0.12	0.60±0.23	0.72±0.33	0.71±0.26	0.78±0.25
60	Biscuit	0.91±0.14	0.80±0.24	0.85±0.31	0.89±0.24	1.01±0.14
	Chips	0.61±0.16	0.61±0.28	0.73±0.32	0.72±0.28	0.79±0.19
90	Biscuit	0.92±0.17	0.80±0.29	0.85±0.32	0.89±0.26	1.02±0.17
	Chips	0.62±0.18	0.62±0.30	0.73±0.26	0.73±0.28	0.80±0.18
120	Biscuit	0.92±0.19	0.81±0.15	0.87±0.26	0.92±0.27	1.03±0.25
	Chips	0.65±0.16	0.65±0.24	0.75±0.28	0.76±0.29	0.82±0.23
150	Biscuit	0.96±0.14	0.86±0.25	0.90±0.11	0.95±0.25	1.06±0.20
	Chips	0.70±0.15	0.71±0.26	0.80±0.20	0.83±0.028	0.86±0.21
180	Biscuit	1.10±0.13	0.95±0.24	1.12±0.26	1.19±0.13	1.24±0.29
	Chips	0.82±0.13	0.78±0.28	0.88±0.36	0.91±0.25	1.00±0.14

Table 5. Effect of different treatments on peroxide value (mg/g) of Biscuit and Chips with biodegradable film during storage

Storage (d)	Sample	Treatments				
		T_0	T_1	T_2	T_3	T_4
30	Biscuit	3.91±0.23	3.92±0.25	4.74±0.32	4.38±0.23	4.12±0.12
	Chips	4.21±0.21	4.34±0.23	4.24±0.12	4.13±0.21	3.93±0.11
60	Biscuit	3.94±0.22	3.96±0.24	4.75±0.15	4.39±0.19	4.13±0.16
	Chips	4.23±0.27	4.36±0.25	4.36±0.19	4.17±0.12	4.03±0.14
90	Biscuit	3.96±0.28	3.98±0.28	4.84±0.17	4.43±0.25	4.15±0.12
	Chips	4.36±0.26	4.38±0.29	4.37±0.28	4.18±0.24	4.04±0.17
120	Biscuit	3.98±0.24	4.03±0.26	4.86±0.15	4.45±0.26	4.19±0.19
	Chips	4.38±0.25	4.39±0.24	4.39±0.14	4.23±0.24	4.06±0.18
150	Biscuit	4.11±0.26	4.89±0.21	5.06±0.11	5.13±0.28	5.27±0.12
	Chips	4.48±0.23	4.50±0.23	4.70±0.16	4.93±0.23	5.13±0.13
180	Biscuit	4.30±0.24	5.13±0.25	5.33±0.14	5.52±0.21	5.70±0.15
	Chips	4.52±0.25	4.78±0.14	4.99±0.15	5.14±0.20	5.47±0.14

hydro peroxides formed in the initial stages of lipid oxidation. Generally, the peroxide value should be less than 10 mg/g oil in the fresh oils. The results showed that the peroxide values varied widely in the biscuit, ranging from 3.91- 5.70 mg/grespectively. The increase the peroxide value of biscuit was minimum 3.91 mg/g in T_0 and maximum 5.70mg/g in T_4.For the potato chips it varies from 4.21- 5.47mg/g. The increase the peroxide value of biscuit was minimum 3.93 mg/g in T_4 and maximum 5.47mg/g in T_4. The oils with high peroxide values are unstable and easily become rancid. Similarly results were obtained by (Nattra *et al.,* 2015 and Manikantan *et al.,* 2012).

CONCLUSION

An overall migration study was conducted on biodegradable packaging material using simulant B for biscuits and chips using simulants as per BIS standard. Overall migration values were well below the safety limits as per different international standards according to EU plastic regulation. The quality parameters viz., moisture content, acid value, free fatty acid and peroxide value of biscuits and chips in biodegradable packaging films increased during 180ds storage period. The T_1(95:5) found to be best than other treatments based on results. This study will definitely find place for biodegradable food packaging films applicability in other high value food products also.

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