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Studies on Preparation and Preservation of Wood Apple Spicy Toffee

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ABSTRACT: Wood apple spicy toffees were developed with different recipes containing 2 levels of sugar, caramel sugar, spice mixture and constant levels of garlic powder, rock salt and evaluated for changes in chemical and sensory parameters at monthly intervals during a storage period of 3 months at ambient conditions. Total soluble solids (TSS), pH, non-enzymatic browning, total and reducing sugar content of toffees were found to increase marginally whereas, moisture, ascorbic acid, titratable acidity, non-reducing sugars, calcium, phosphorus and iron content were decreased with the advancement of storage period. The sensory quality parameters *viz*., color and appearance, flavor, taste, texture and overall acceptability of wood apple toffees were decreased significantly during the storage period however, the products were acceptable even after three months of storage at ambient conditions.

Keywords: Wood apple, spicy toffee, spice mixture, organoleptic characters.

INTRODUCTION

The wood apple (*Feronia limonia* Swingle) belongs to the family Rutaceae, is commonly found in dry deciduous forests (Mazumder *et al*., 2006). The significance of the wood apple fruit lies in its curative properties, the fruit is used in India as a liver and cardiac tonic when unripe as astringent means of halting diarrhea and dysentery (Singhania and Ray 2019), effective treatment for hiccups, sore throat and diseases of gums (Kerkar *et al*., 2020), the pulp is poultice onto bites and stings of venomous insects also it has hypoglycaemic, antitumor, antidiabetic, anti-inflammatory, antioxidant, antimicrobial and hepatoprotective activity (Srivastava *et al*., 2019). This fruit is considered to be one of the natural sources of anti-oxidants due to its potential radical scavenging activity of various phytochemicals (Moazzem *et al*., 2019).

The flesh of the wood apple fruit is sweet, somewhat acidic, aromatic and has high nutritional value. The fruit comprises (40.47 to 66.46%) pulp, seed (3.31 to 12.48%), fibre (3.85 to 5.08%), moisture (65.32 to 74.04%), TSS (12.08 to 18.44^{o}B), acidity (2.44 to 6.12%), brix: acid (2.46 to 6.48), pH (2.80 to 3.54), total sugars (2.23 to 6.83%), pectin (1.02 to 2.13%), vit-C (2.88 to 6.24 mg/100 g), vit-B_{12} (0.05 to 0.27 mg/100 g), calcium (80.1 to 111.35 mg/100 g), phosphorus (37.10 to 69.17 mg/100 g) and iron (0.05 to 16.29 mg/100 g) (Gorabal, 2020).

Because of its excellent flavor and nutritive value, this fruit has a great potential for value addition. A wide variety of value-added products can be prepared from this fruit including beverages, jam, jelly and leather (Gorabal *et al*., 2020). The fruit is not popular as a dessert fruit because it exhibits difficulty while eating as it has a hard shell, sticky texture and abundant seeds. Therefore, it is not easily marketed in fresh form and should be processed into acceptable products (Gowda, 2017).

Toffee is one of the confectionary nutritional products, has a chewy texture and is a good source of dietary fibre and natural sugar hence product is liked by all age groups peoples (Bhokre *et al*., 2010). Nowadays global demand for fruit-based toffees were increasing day by day (Shastri *et al*., 1979: Domale *et al*., 2008). The toffee can be better utilized as a vehicle to promote consumption and utilization of wood apple fruit, which have otherwise less market demand and quite limited shelf life therefore a study was conducted to exploit the excellent and delightful pulp characters having a potential, nutritional and medicinal value of wood apple fruits by converting them into spicy toffee which would help to overcome the market glut and thereby assure the economic prices to the fruit.

MATERIAL AND METHODS

An experiment was carried out during 2020-21 in the Department of Post Harvest Technology, KRC College of Horticulture, Arabhavi (UHS, Bagalkot), Karnataka. The fully ripe fruits were selected for toffee preparation and the methodology used for the preparation of spicy toffee is mentioned in Fig. 1.

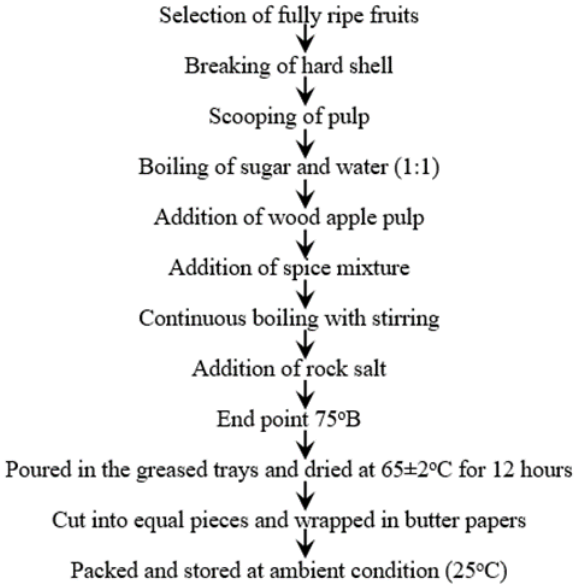

Fig. 1. Flowchart for preparation of wood apple spicy toffee.

The Products were analyzed for moisture content using a moisture analyzer (Model: P1019319, A & D Company Limited, Japan). TSS (°B) was measured by using an 'Erma' make hand refractometer after necessary corrections. Titratable acidity (%) and ascorbic acid (mg/100 g) content was estimated as per the modified procedure of AOAC (Anon., 1984). The non-enzymatic browning (OD value) was estimated according to the procedure of Srivastava and Sanjeevkumar (1998). Reducing sugars were estimated as per the Dinitro-salicylic acid method (Miller, 1972). The total sugar content was estimated as per the procedure given in AOAC (Anon., 1984). The per cent non-reducing sugars were obtained by subtracting the values of reducing sugars from that of total sugars. The minerals such as calcium, phosphorus and iron present in the spicy toffee were estimated as per the procedure given in AOAC (Anon., 1990). The organoleptic characters were evaluated by a panel of semi-trained judges consisting of teachers and post-graduate students of KRC College of Horticulture, Arabhavi, on a nine-point hedonic scale as per the method of Ranganna (2003). The total bacterial and fungal count was taken as per the method of Harrigan and Mc-Cance (1966). The data recorded on the Physico-chemical and organoleptic parameters were subjected to statistical analysis in CRD. The interpretation of data was carried out in accordance with Panse and Sukhatme (1985). The level of significance used in the 'F' test was p=0.01.

Table 1: Spicy toffee prepared by incorporating a different level of sugar, brown sugar and spice mixture.

T_1	1000 g sugar + 80 g spice mixture + 5 g garlic powder + 2 g rock salt
T_2	1000 g sugar + 100 g spice mixture + 5 g garlic powder + 2 g rock salt
T_3	1000 g brown sugar + 80 g spice mixture + 5 g garlic powder + 2 g rock salt
T_4	1000 g brown sugar + 100 g spice mixture + 5 g garlic powder + 2 g rock salt
T_5	750 g sugar + 80 g spice mixture + 5 g garlic powder + 2 g rock salt
T_6	750 g sugar + 100 g spice mixture + 5 g garlic powder + 2 g rock salt
T_7	750 g brown sugar + 80 g spice mixture + 5 g garlic powder + 2 g rock salt
T_8	750 g brown sugar + 100 g spice mixture + 5 g garlic powder + 2 g rock salt

RESULTS AND DISCUSSION

Effect of different recipes on the nutritional quality of wood apple spicy toffee. The nutritional quality of wood apple spicy toffee was affected by the advancement of the storage period. The moisture content of spicy toffee decreased from 12.87 to 12.31 per cent during the storage period (Table 2) could be due to the natural dehydration of the product (Aggarwal and Kaur 2014). Similar observations were made by Gorabal (2020) in the wood apple fruit bar. The TSS was increased (78.00 to 78.06°B)

throughout the entire period of storage (Table 2) due to acid hydrolysis of insoluble polysaccharides especially gums and pectin into soluble sugars, the results were in accordance with the findings of Nalage *et al*. (2014) in aonla ginger mixed toffee. The ascorbic acid content of spicy toffee was found to decrease (1.98 to 1.74 mg/100 g) during storage due to the conversion of ascorbic acid to di-hydroxy ascorbic acid (Table 2), titratable acidity decreased from 2.37 to 2.28 per cent during storage it might be due to the reaction of acids with basic minerals in the products. The pH was increased from 3.60 to 3.65during the storage period (Table 3) might be due to a decrease in the acid concentrations in toffees. Similar results were noticed by Vidhya and Narin (2011) in wood apple bar and Panna *et al*. (2019) in guava toffee. Similar findings *i.e.* decrease in ascorbic acid and titratable acidity during storage were also reported by Chavan *et al.* (2016) in guava toffee.

Progressive increase (1.01 to 1.05) in browning (O. D. values) of spicy toffee was observed with the advancement of the storage period (Table 3). It may be due to the formation of furfural and hydroxyl furfural by aerobic and anaerobic degradation of ascorbic acid, sugars and organic acids (Kumar *et al*., 2019). The same type of findings was noticed by Nayak *et al*. (2012) in aonla candy.

The total and reducing sugars were increased (61.21 to 61.42% and 16.14 to 16.56%, respectively) and non-reducing sugars were decreased (42.82 to 42.61%) throughout the storage period (Table 4). The increase in the total and reducing sugar content of toffee could be due to acid hydrolysis of insoluble polysaccharides especially gums and pectin into soluble sugars. On the other hand, the non-reducing sugars were decreased during the storage period, this might be due to inversion. The results were in accordance with the findings of Kohinkar *et al.* (2012) in fig and guava toffee and Chavan *et al.* (2016) in guava toffee.

A negligible reduction in the calcium, phosphorus and iron content (27.07 to 27.04, 34.13 to 34.11 and 4.19 to 4.16 mg/100 g) in toffee was observed (Table 5). This was due to the light, oxygen and water content will affect the mineral content of the product during storage, which will result in oxidation and reduction of these minerals. Vidhya and Narain (2011); Gorabal (2020) also noticed similar kinds of results in wood apple bar stored for 3 months under ambient condition.

Effect of different recipes on organoleptic quality and safety of wood apple spicy toffee. The spicy toffee exhibited significant variations with respect to all the sensory quality parameters. The mean organoleptic scores decreased from an initial value of 8.19 to 7.63 for color and appearance, 7.09 to 6.71 for flavor, 7.69 to 6.98 for taste, 7.91 to 7.17 for texture and 7.72 to 7.20 for overall acceptability during the storage period of 3 months (Table 6 and 7). The overall decline in the sensory score during the storage may be due to some undesirable changes taking place in the product during storage. Similar results were noticed by Kumar *et al*. (2019) in aonla and papaya toffee; Gorabal (2020) in wood apple fruit bar.

No microbial growth was observed during the storage period. Ensuring that, the product was safe even after 90 days of storage, because of the less moisture, low water activity of spicy toffee and high acidic nature of pulp.

Table 2: Changes in moisture content, total soluble solids and ascorbic acid of wood apple spicy toffee as influenced by treatments and storage period.

Treatments	Moisture content (%)				Total soluble solids (°B)				Ascorbic acid (mg/100 g)			
	Months after storage											
	Initial	1	2	3	Initial	1	2	3	Initial	1	2	3
T_1	12.82	12.62	12.38	12.26	78.06	78.06	78.08	78.12	1.92	1.85	1.76	1.69
T_2	12.76	12.54	12.24	12.11	78.12	78.14	78.15	78.19	1.99	1.87	1.80	1.72
T_3	12.81	12.67	12.40	12.33	78.14	78.15	78.15	78.16	1.95	1.86	1.74	1.67
T_4	12.94	12.72	12.55	12.48	78.08	78.11	78.14	78.17	2.03	1.94	1.87	1.80
T_5	12.78	12.55	12.31	12.10	77.92	77.95	77.97	77.98	1.89	1.79	1.71	1.66
T_6	12.86	12.68	12.23	12.13	77.86	77.88	77.90	77.93	2.05	1.97	1.90	1.83
T_7	13.00	12.81	12.58	12.64	77.88	77.90	77.92	77.93	1.94	1.87	1.79	1.70
T_8	12.96	12.73	12.55	12.42	77.90	77.93	77.95	77.98	2.07	1.96	1.89	1.81
Mean	**12.87**	**12.67**	**12.40**	**12.31**	**78.00**	**78.02**	**78.03**	**78.06**	**1.98**	**1.89**	**1.81**	**1.74**
S.Em±	0.008	0.011	0.009	0.010	0.016	0.030	0.016	0.014	0.020	0.014	0.014	0.013
C.D. @ 1%	0.034	0.045	0.039	0.043	0.064	0.123	0.065	0.057	0.081	0.059	0.057	0.055

Treatment details

T_1 – 1000 g sugar + 80 g spice mixture
T_2– 1000 g sugar + 100 g spice mixture
T_3 – 1000 g brown sugar + 80 g spice mixture
T_4 – 1000 g brown sugar + 100 g spice mixture
T_5– 750 g sugar + 80 g spice mixture
T_6– 750 g sugar + 100 g spice mixture
T_7– 750 g brown sugar + 80 g spice mixture
T_8 – 750 g brown sugar + 100 g spice mixture

Table 3: Changes in titratable acidity, pH and non enzymatic browning of wood apple spicy toffee as influenced by treatments and storage period.

Treatments	Titratable acidity (%)				pH				Non enzymatic browning (OD value)			
	Months after storage											
	Initial	1	2	3	Initial	1	2	3	Initial	1	2	3
T_1	2.33	2.28	2.25	2.22	3.62	3.63	3.65	3.66	0.89	0.91	0.92	0.92
T_2	2.39	2.34	2.30	2.28	3.59	3.60	3.62	3.63	0.91	0.93	0.94	0.95
T_3	2.32	2.28	2.25	2.21	3.63	3.64	3.66	3.67	1.13	1.14	1.15	1.17
T_4	2.41	2.39	2.36	2.35	3.58	3.60	3.61	3.62	1.15	1.16	1.18	1.19
T_5	2.35	2.32	2.29	2.26	3.60	3.60	3.62	3.65	0.78	0.80	0.82	0.83
T_6	2.42	2.40	2.36	2.33	3.58	3.59	3.62	3.64	0.81	0.82	0.83	0.85
T_7	2.37	2.32	2.28	2.25	3.60	3.61	3.63	3.65	1.20	1.22	1.23	1.24
T_8	2.40	2.35	2.32	2.30	3.59	3.60	3.62	3.65	1.23	1.23	1.25	1.27
Mean	**2.37**	**2.33**	**2.30**	**2.28**	**3.60**	**3.61**	**3.63**	**3.65**	**1.01**	**1.03**	**1.04**	**1.05**
S.Em±	0.010	0.008	0.008	0.010	0.014	0.014	0.017	0.021	0.001	0.001	0.001	0.001
C.D. @ 1%	0.040	0.032	0.032	0.043	NS	NS	NS	NS	0.003	0.004	0.004	0.003

Note: OD- Optical density NS: Non significant

Treatment details

T_1– 1000 g sugar + 80 g spice mixture
T_2 – 1000 g sugar + 100 g spice mixture
T_3 – 1000 g brown sugar + 80 g spice mixture
T_4 – 1000 g brown sugar + 100 g spice mixture
T_5 – 750 g sugar + 80 g spice mixture
T_6– 750 g sugar + 100 g spice mixture
T_7– 750 g brown sugar + 80 g spice mixture
T_8– 750 g brown sugar + 100 g spice mixture

Table 4: Changes in total sugars, reducing sugars and non-reducing sugars of wood apple spicy toffee as influenced by treatments and storage period.

Treatments	Total sugars (%)				Reducing sugars (%)				Non reducing sugars (%)			
	Months after storage											
	Initial	1	2	3	Initial	1	2	3	Initial	1	2	3
T_1	61.53	61.59	61.65	61.71	16.35	16.52	16.65	16.76	42.92	42.82	42.75	42.70
T_2	61.62	61.71	61.79	61.87	16.38	16.53	16.70	16.81	42.98	42.92	42.84	42.81
T_3	61.48	61.55	61.59	61.63	16.33	16.48	16.59	16.69	42.89	42.82	42.75	42.69
T_4	61.63	61.74	61.79	61.85	16.40	16.53	16.77	16.91	42.97	42.95	42.77	42.69
T_5	60.78	60.88	60.96	61.02	15.88	16.03	16.16	16.27	42.66	42.61	42.56	42.51
T_6	60.90	60.97	61.07	61.12	15.95	16.10	16.23	16.38	42.70	42.63	42.60	42.50
T_7	60.81	60.87	60.97	61.03	15.85	15.98	16.10	16.23	42.71	42.65	42.63	42.56
T_8	60.93	60.97	61.05	61.09	15.97	16.13	16.31	16.43	42.71	42.60	42.50	42.43
Mean	**61.21**	**61.29**	**61.36**	**61.42**	**16.14**	**16.29**	**16.44**	**16.56**	**42.82**	**42.75**	**42.67**	**42.61**
S.Em±	0.026	0.025	0.020	0.023	0.015	0.015	0.016	0.012	0.019	0.025	0.020	0.024
C.D. @ 1%	0.106	0.104	0.084	0.094	0.060	0.062	0.065	0.051	0.080	0.102	0.083	0.099

Treatment details

T_1 – 1000 g sugar + 80 g spice mixture
T_2– 1000 g sugar + 100 g spice mixture
T_3 – 1000 g brown sugar + 80 g spice mixture
T_4– 1000 g brown sugar + 100 g spice mixture
T_5– 750 g sugar + 80 g spice mixture
T_6– 750 g sugar + 100 g spice mixture
T_7 – 750 g brown sugar + 80 g spice mixture
T_8– 750 g brown sugar + 100 g spice mixture

Table 5: Changes in calcium, phosphorus and iron content of wood apple spicy toffee as influenced by treatments and storage period.

Treatments	Calcium (mg/100 g)				Phosphorus (mg/100 g)				Iron (mg/100 g)			
	Months after storage											
	Initial	1	2	3	Initial	1	2	3	Initial	1	2	3
T_1	27.03	27.01	27.00	26.99	34.11	34.10	34.10	34.09	4.13	4.13	4.12	4.11
T_2	27.11	27.10	27.10	27.09	34.16	34.14	34.13	34.13	4.24	4.23	4.21	4.21
T_3	27.02	27.01	27.00	26.98	34.09	34.09	34.07	34.07	4.14	4.14	4.13	4.11
T_4	27.09	27.07	27.06	27.04	34.17	34.16	34.15	34.15	4.26	4.25	4.24	4.22
T_5	27.04	27.03	27.01	27.01	34.10	34.08	34.07	34.06	4.12	4.12	4.11	4.10
T_6	27.12	27.10	27.09	27.08	34.17	34.16	34.16	34.15	4.26	4.24	4.24	4.23
T_7	27.04	27.04	27.03	27.01	34.12	34.10	34.10	34.09	4.13	4.12	4.11	4.10
T_8	27.12	27.12	27.11	27.09	34.15	34.14	34.12	34.11	4.25	4.25	4.24	4.22
Mean	**27.07**	**27.06**	**27.05**	**27.04**	**34.13**	**34.12**	**34.11**	**34.11**	**4.19**	**4.19**	**4.17**	**4.16**
S.Em±	0.004	0.005	0.006	0.006	0.008	0.008	0.005	0.007	0.003	0.004	0.004	0.003
C.D. @ 1%	0.015	0.021	0.026	0.024	0.032	0.033	0.021	0.029	0.011	0.015	0.016	0.011

Treatment details

T_1 – 1000 g sugar + 80 g spice mixture
T_2– 1000 g sugar + 100 g spice mixture
T_3 – 1000 g brown sugar + 80 g spice mixture
T_4 – 1000 g brown sugar + 100 g spice mixture
T_5 – 750 g sugar + 80 g spice mixture
T_6– 750 g sugar + 100 g spice mixture
T_7 – 750 g brown sugar + 80 g spice mixture
T_8 – 750 g brown sugar + 100 g spice mixture

Table 6: Changes in color and appearance, flavor and taste of wood apple spicy toffee as influenced by treatments and storage period (9 point hedonic scale).

Treatments	Colour and appearance				Flavor				Taste			
	Months after storage											
	Initial	1	2	3	Initial	1	2	3	Initial	1	2	3
T_1	8.17	8.17	8.00	7.67	7.17	7.08	7.00	6.83	7.33	7.33	7.00	6.83
T_2	8.17	8.00	8.00	7.67	6.83	6.50	6.42	6.33	7.17	7.00	6.83	6.67
T_3	8.00	7.83	7.50	7.33	7.17	7.00	7.00	6.83	7.33	7.00	6.50	6.33
T_4	8.00	7.83	7.67	7.33	6.92	6.83	6.50	6.33	7.17	7.00	6.83	6.50
T_5	8.67	8.67	8.50	8.33	7.33	7.33	7.17	7.00	8.33	8.33	8.17	8.00
T_6	8.50	8.33	8.17	8.00	7.00	7.00	6.83	6.83	8.17	8.00	7.83	7.67
T_7	8.00	7.83	7.50	7.33	7.33	7.17	7.00	7.00	8.00	7.50	7.33	7.00
T_8	8.00	7.67	7.33	7.33	7.00	7.00	6.83	6.50	8.00	7.67	7.00	6.83
Mean	**8.19**	**8.04**	**7.83**	**7.63**	**7.09**	**6.99**	**6.84**	**6.71**	**7.69**	**7.48**	**7.19**	**6.98**
S.Em±	0.102	0.156	0.144	0.156	0.125	0.106	0.106	0.132	0.144	0.144	0.132	0.132
C.D. @ 1%	0.422	0.644	0.596	0.644	NS	0.439	0.439	0.544	0.596	0.596	0.544	0.544

NS: Non significant

Treatment details

T_1 – 1000 g sugar + 80 g spice mixture
T_2 – 1000 g sugar + 100 g spice mixture
T_3 – 1000 g brown sugar + 80 g spice mixture
T_4 – 1000 g brown sugar + 100 g spice mixture
T_5– 750 g sugar + 80 g spice mixture
T_6– 750 g sugar + 100 g spice mixture
T_7 – 750 g brown sugar + 80 g spice mixture
T_8– 750 g brown sugar + 100 g spice mixture

Table 7: Changes in texture and overall acceptability of wood apple spicy toffee as influenced by treatments and storage period (9 point hedonic scale).

Treatments	Texture				Overall acceptability			
	Months after storage							
	Initial	1	2	3	Initial	1	2	3
T_1	8.00	8.00	7.83	7.67	7.67	7.65	7.46	7.25
T_2	7.83	7.83	7.50	7.33	7.50	7.33	7.19	7.00
T_3	8.00	8.00	7.67	7.50	7.63	7.46	7.17	7.00
T_4	7.75	7.50	7.33	7.17	7.46	7.29	7.08	6.83
T_5	8.00	8.00	7.83	7.83	8.08	8.08	7.92	7.79
T_6	7.83	7.83	7.67	7.50	7.88	7.79	7.63	7.51
T_7	8.00	7.83	7.67	7.50	7.83	7.58	7.38	7.21
T_8	7.83	7.67	7.50	7.33	7.71	7.50	7.17	7.00
Mean	**7.91**	**7.83**	**7.63**	**7.17**	**7.72**	**7.59**	**7.37**	**7.20**
S.Em±	0.114	0.156	0.177	0.899	0.061	0.079	0 .076	0.090
C.D. @ 1%	NS	NS	NS	NS	0.251	0.326	0.315	0.371

NS: Non significant

Treatment details

T_1 – 1000 g sugar + 80 g spice mixture
T_2 – 1000 g sugar + 100 g spice mixture
T_3 – 1000 g brown sugar + 80 g spice mixture
T_4 – 1000 g brown sugar + 100 g spice mixture
T_5– 750 g sugar + 80 g spice mixture
T_6– 750 g sugar + 100 g spice mixture
T_7– 750 g brown sugar + 80 g spice mixture
T_8 – 750 g brown sugar + 100 g spice mixture

CONCLUSION

From the above results, spicy toffee is prepared from a recipe containing 750 g sugar + 80 g spice mixture + 5 g garlic powder + 2 g rock salt (T_5) and 750 g sugar + 100 g spice mixture + 5 g garlic powder + 2 g rock salt (T_6) resulted in superior quality with respect to Physico-chemical characters and organoleptic traits.

FUTURE SCOPE

The nutritional values, as well as the medicinal properties of wood apple fruits, can be well exploited through different value-added products. Among value-added products, toffee is the one liked by all age groups. Protein or mineral fortified wood apple toffees may be tried and they may act as a tool for the reduction of malnutrition in children. Scope for development of jaggery-based wood apple toffees and also mixed fruit toffee of wood apple with other fruits such as date palm, guava and mango may be tried.

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Conflict of interest. None.

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