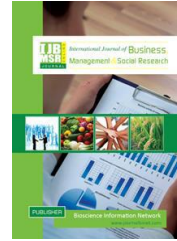


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Assessment of postharvest loss and constrains in the supply chain of mango

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ABSTRACT

This study was conducted to assess postharvest quantitative losses including constrains in the supply chain of mango. The survey was conducted using structured and pre-tested interview schedules at four levels of mango supply chain including growers, 'Bepari', wholesalers, and retailers. For growers' interview, four Upazillas of Chapai Nawabganj (Chapai Nawabganj Sadar, Shibganj, Bholahat, and Gomostapur) and two upazillas of Rajshahi (Charghat and Bagha) were selected. For 'Bepari', wholesalers, and retailers survey was carried out in local assemble markets of Chapai Nawabganj and Rajshahi; wholesale and retail markets of Mymensingh and Dhaka. Nature of damage of mango was mainly bruises, cuts, sap burn, and vibration damage. The total postharvest loss of mango starting from harvest at growers' level to different steps of postharvest supply chain was 30.65%. The individual losses at growers', 'Bepari', wholesalers, and retailers' levels were estimated to be 4.4%, 8.43%, 9.21%, and 8.61%, respectively. These losses occurred due mainly to the sub-standard handling practices, lack of proper transport and storage facilities, and ignorance of the stakeholders. To the growers, the major problems were related to fertilizer (adulteration and availability), and insect and disease attacks. To the intermediaries ('Bepari', wholesalers, and retailers) the major problems were concerned with transportation and storage facility.

Key Words: Mango, supply chain, survey, postharvest loss and constrains.

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I. Introduction

The mango (*Mangifera indica* L.), belongs to dicotyledonous family *Anacardiaceae* eulogized as the king of fruits. Mango is believed to originated from South Asia or Malayan archipelago (Salukhe and

Desai, 1984; Shajahan et al., 1994). The total area under mango cultivation in Bangladesh is 44366 ha and the total production is 11,65,804 metric ton (BBS, 2019). Mangoes are rich sources of vitamins and minerals (Paramanik, 1995). It is also a moderate source of carbohydrate as ripe mango pulp contains 16.9% carbohydrate (Salunkhe and Desai, 1984). According to Gopalan et al. (1989) 100 g ripe mango contains 81 g moisture, 0.6 g protein, 0.4 g fat, 0.4 g minerals, 0.7 crude fibre, 16.9 g carbohydrates, 74 Kcal. energy, 14 mg calcium, 16 mg phosphorus, 1.3 mg iron. The matter is further compounded by the huge postharvest losses of fruits, especially those of the climacteric fruits like mango. A large quantity of harvested fruits goes waste due to lack of proper postharvest handling and storage facilities. The magnitude of postharvest losses in fresh fruit is estimated to be 5-25% in developed countries, and 20-50% in developing countries (Khader, 1985). Postharvest losses of fruits occur at all stages in the postharvest handling from harvesting to consumption. Among the fruits, mango manifested high postharvest loss because of its high perishability and climacteric pattern of respiration. Statistical data to indicate the magnitude of postharvest loss of mango in Bangladesh are meager. Singh (1960) reported from India that the postharvest loss of fresh mango fruit due to microbial decay varied from 20-33%. Srinivas et al. (1997) provided more specific reports on postharvest losses of mango. The losses of varieties 'Totapuri' and 'Alphonso' were 17.9% (3.5% in orchard, 4.9% during transportation, 4.1% in storage, and 5.4% in retail level) and 14.4% (1.9% orchard, 3.7% during transportation, 3.7% in storage, and 5.3% in retail level), respectively. Similar estimations were also reported by Quroshi and Meah (1991) (0 to 16.3%). The postharvest losses in tropical fruits vary widely from 10 to 80% in both developed and developing countries (Paul, 2001). Therefore, a critical area of examination would be to determine the magnitude of the losses in different handling steps in Bangladesh along with the constraints of the stakeholders in the supply chain. In Bangladesh, some studies on postharvest behavior of mango have been conducted by several researchers (Absar et al., 1993; Hassan et al., 1998 and Sarder et al., 1998). But little information is available on postharvest quantitative losses of mango in Bangladesh. Therefore, the present study was undertaken to assess the magnitude of postharvest quantitative losses of mango at harvest and at different stages of mango supply chain.

II. Materials and Methods

An extensive survey was conducted at four levels of mango supply chain, and the levels were growers, 'Bepari', wholesalers, and retailers during the period of May to August, 2009. Growers of Sadar, Shibganj, Bholahat and Gomostapur of Chapai Nawabganj Districts; and Bhaga and Charchhat of Rajshahi District were the population for in the present study. Names of the mango growers from major-growing block of each Upazilla of the two districts were listed. Then 25 growers (sample) from the population were randomly selected for interview. A total of 150 growers were interviewed. During the data collection from the 'Bepari', 25 mango 'Bepari' were randomly selected from each of the local assemble markets of Chapai Nawabganj Sadar, Shibganj; and Gomostapur, Puthia in Chapai Nawabganj and Rajshahi districts, respectively. A total of 100 'Bepari' were interviewed. The wholesalers were randomly selected from Karwan Bazar and Badamtoli wholesale markets of Dhaka, Notun Bazar and Machoua Bazar of Mymensingh Sadar, and Charchhat Bazar of Charchhat Upazilla, Rajshahi. A total of 100 wholesalers were interviewed. The retailers were randomly selected from Natun Bazar, Machoua Bazar and Charpara of Mymensingh Sadar, Sadarchhat and Sutrapur of Dhaka, and Shaheb Bazar of Rajshahi district. A total of 100 retailers were interviewed. In order to collect information which are relevant with the present survey, four sets of interview schedules were prepared keeping the objectives of the research in mind. Four sets of interview schedules were designed for growers, 'Bepari', wholesalers, and retailers. The schedules were prepared in Bengali for ease of understanding by the respondents. The interview schedules were pre-tested in actual field condition/situations, and necessary corrections, modifications and alternations were made before finally printing the schedules. The respondents' opinions were transformed to a master sheet to facilitate tabulation. Tabulation and computation were done on the basis of categories developed. Qualitative data were converted into quantitative ones by means of suitable scoring (if required). For describing the collected information, categories were developed in relation to each of the selected respondents to have better understanding of the characteristics of the growers, intermediaries and consumers. Different categories according to their respective characteristics were developed. Procedures for developing the categories have been discussed while describing the characteristics of respondents in the results and discussion part. The data collected from the respondents were compiled, tabulated and analyzed in

accordance with the objectives of the study. Various statistical measures such as number and percentage distribution, range, mean, standard deviation and rank order used in describing the performance and selected characteristics of the respondents. Domestic marketing channels for fruits in Bangladesh has been shown in [Figure 01](#).

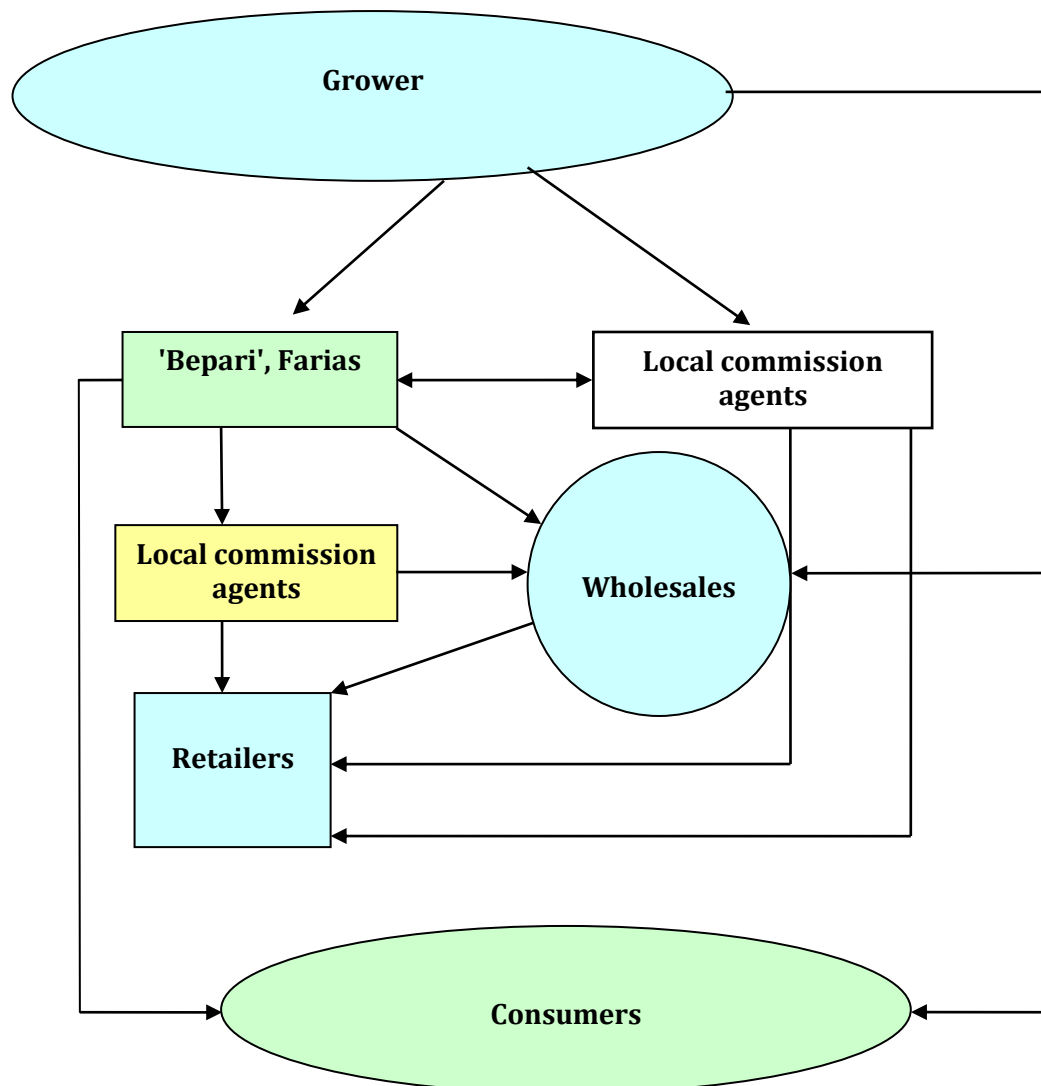


Figure 01. Domestic marketing channels for fruits in Bangladesh (Project formulation survey on export possibility of agricultural products in Bangladesh. Japan International Cooperative Agency, Dhaka, 1993)

III. Results and Discussion

Respondent: Grower

Nature of damage: Bruises were the major cause of mango postharvest damage in the grower stage. 72-100% grower replied that maximum damage occurs due to bruises followed by cuts (24-64%) ([Table 01](#)). This is probably due to conventional harvesting methods, ignorance of the pickers, and most importantly due to the carelessness of the pickers.

Constrains in mango cultivation at farmers level: In both Districts, the problems were mainly related to fertilizer (12-44)%, irrigation problem (8-24)%, insect (16-64)% and disease (8-28)% attacks ([Table 02](#)). Fertilizer problem due to high cost and unavailability of fertilizers, irrigation problem occurs because of higher temperature and low precipitation in Chapai Nawabganj and Rajshahi districts and higher price of fuel 24-48% growers replayed that they have no problem in mango production.

Table 01. Nature of damage occurred to the fruits at harvest Chapai Nawabganj and Rajshahi

District/ Upazilla		Bruises	Blemishes	Cuts	Sap burn	Fruit cracking	No damage
Chapai Nawabganj							
C. N Sadar (n=25)	%	88	0	36	20	4	4
Shibganj (n=25)	%	88	4	48	28	4	0
Bholahat (n=25)	%	100	0	16	12	12	12
Gomostapur (n=25)	%	84	0	64	8	8	4
Rajshahi							
Charghat (n=25)	%	72	0	24	12	0	0
Gomostapur (n=25)	%	84	0	64	8	8	4

N.B Due to duplication and overlapping sources exceed 25.

Table 02. Constrains in mango cultivation at farmers level

District/ Upazilla		Diseases	Insect	Money	Irrigation	Fertilizer	Transport	LC	No problem	*Others
Chapai Nawabganj										
Chapai Nawabganj Sadar (n=25)	%	20	8	12	16	24	0	8	48	0
Shibganj (n=25)	%	16	20	4	24	40	0	0	52	4
Bholahat (n=25)	%	40	12	16	24	28	4	0	24	12
Gomostapur (n=25)	%	64	28	20	16	44	0	0	8	0
Rajshahi										
Bagha (n=25)	%	60	24	0	8	12	0	0	24	0
Charghat (n=25)	%	40	24	16	12	32	0	0	24	4

*Others problem includes problem of grafted plant and climatic hazard. **NB.** Due to duplication and overlapping sources exceed 25.

Losses of mango at growers' level: In the six Upazillas of Chapai Nawabganj and Rajshahi postharvest loss in the grower level are shown in [Table 03](#). The highest loss was seen 6.6% in Bholahat and lowest 2% in Gomostapur of Chapai Nawabganj. It may due to cultivation techniques, harvesting and handling methods of the growers. The average postharvest loss at growers' level is 4.40%. This finding was similar with [Nanda et al. \(2010\)](#).

Table 03. Harvest loss of mango at the growers' level in the surveyed Upazillas of Chapai Nawabganj and Rajshahi Districts

Upazilla	Chapai Nowabganj				Rajshahi	
	Chapai Nawabganj (n=25)	Shibganj (n=25)	Bholahat (n=25)	Gomostapur (n=25)	Charghat (n=25)	Bagha (n=25)
Postharvest loss (%)	6.10	4.82	6.66	2	3.86	2.96
Minimum (%)	2	1.50	2	1.50	0	0
Maximum (%)	12.50	10	10	15	10	10
Standard deviation	3.09	2.61	3.12	2.07	1.57	1.98

Respondent: 'Bepari'

Damage occurs during transport and storage: Damage occurs during transport and storage at wholesalers' level by means of bruises, cuts and diseases. Maximum damage (28-100%) was due to bruises followed by blemishes (0-88%) ([Table 04](#)).

Problems faced by the 'Bapari' mango businesses: In the surveyed assemble markets of Chapai Nawabganj and Rajshahi districts, the problems were mainly related to transport lack of storage, low price and fund. Most common problem was lack of storage facilities (28-40% 'Bepari'). Second important problem was lack of proper transport (12-36%) ([Table 05](#)).

Table 04. Nature of damage occurred to mango fruits during transport

Nature of damage during transportation	Districts/Upazilla			
	Chapai Nawabganj			Rajshahi
	Chapai Nawabganj Sadar (n=25)	Gomostapur (n=25)	Kansat (Shibganj) (n=25)	Banashor Bazar (n=25)
	%	%	%	%
Cuts	28	0	4	12
Bruises	80	80	100	28
Blemishes	0	80	0	88
Sap burn	24	0	32	12
Vibration damage	12	24	36	16

NB. Due to duplication and overlapping sources exceed 25.

Table 05. Problems faced by mango 'Bepari'

Problems	Chapai Nawabganj			Rajshahi
	Chapai Nawabganj Sadar (n=25)	Gomostapur (n=25)	Kansat (Shibganj) (n=25)	Banashor Bazar (n=25)
	%	%	%	%
None	40	36	52	60
Transport	36	24	20	12
Lack of storage facilities	36	40	28	28
Low price	18	8	0	8
Others (Financial)	16	0	0	0

NB. Due to duplication and overlapping sources exceed 25.

Postharvest loss at 'Bepari' level: At 'Bepari' level, the postharvest loss was highest in Baneshar Bazar (10.14%) of Rajshahi district among the surveyed areas (Table 06). On the other hand, loss was lower in Chapai Nowabganj district which is the largest mango producing district of Bangladesh. This result would be attributed to the use of plastic crates instead of conventional packaging method (bamboo basket and gunny bags) for long distance transport of mango. The average loss at 'Bepari' level was 8.43% in the surveyed area. This loss was occurred due to lack of appropriate transport and storage facilities.

Table 06. Postharvest loss of mango at the 'Bepari' level in the surveyed Upazillas of Chapai Nawabganj and Rajshahi Districts

Upazilla	Chapai Nowabganj			Rajshahi
	Chapai Nowabganj Sadar (n=25)	Gomostapur (n=25)	Kansat (Shibganj) (n=25)	Banashor Bazar (n=25)
Postharvest loss (%)	8.46	8.52	6.62	10.14
Minimum (%)	2	1.5	0	3
Maximum (%)	20.5	25	20	25
Standard deviation	4.61	6.67	4.73	6.34

Respondent: Wholesaler

Damage occurs during transport and storage: Damage occurs during transport and storage at wholesalers' level by means of bruises, cuts and diseases. Maximum damage (40-82%) was due to bruises followed by diseases (48-56%) (Table 07).

Table 07. Damage occurs during transport and storage

Category	Dhaka		Rajshahi
	Badamtoli (n=25)	Karwan Bazar (n=50)	Charghat (n=25)
	%	%	%
Bruises	60	82	40
Cuts	12	36	44
Diseases	48	56	52

NB. Due to duplication and overlapping sources exceed 25.

Problems in mango business to the wholesalers: From the present study it was found that wholesalers face transport, lack of storage facilities, postharvest diseases, financial problem, LC problem. Among these problems lack of storage facilities was most important 7-47% (Table 08). Second most problem was due to lack of transportation since 14-33% of the wholesalers opinioned on this problem.

Table 08. Problems of mango wholesalers in respect of business

Category	Wholesale markets		
	Dhaka		Rajshahi
	Badamtoli (n=25)	Karwan Bazar (n=25)	Charghat (n=25)
	%	%	%
No problem	43	17	19
Transport	33	14	22
Lack of storage facilities	7	34	47
Postharvest diseases	13	26	9
Others*	3	9	3

NB. Due to duplication and overlapping sources exceed 25. * Financial, LC

Postharvest loss at wholesale level: Considerable quantity of mangoes wasted at wholesale level. The higher loss was observed in Karwan Bazar (10.98%) followed by Badamtoli (9.10%) wholesale market of Dhaka district. On the contrary, loss was minimum in Mymensingh Sadar (7.54%). The average loss of mango at wholesale level in the surveyed area was 9.21%. Bruises, cuts, and microbial activity are the major causes of this losses during transport and storage, respectively.

Table 09. Postharvest loss of mango at the growers' level in the surveyed locations of Dhaka and Rajshahi Districts

Locations	Badamtoli (n=25)	Karwan Bazar (n=50)	Charghat (n=25)
Postharvest loss (%)	9.10	10.98	7.54
Minimum (%)	0	0	0
Maximum (%)	25	28.50	25
Standard deviation	5.98	4.96	6.38

Respondent: Retailers

Damage during transport and subsequent sell: 36-92% retailers said that maximum damage occurs due to bruises. Some damage occurs due to cuts (8-16%) and vibration damage (8-12%) (Table 10).

Table 10. Damage during transport at retailers' level

Category	C. N Sadar (n=25)	Mymensingh Sadar (n=25)	Dhaka (n=25)	Rajshahi Sadar (n=25)
	%	%	%	%
Bruises	92	84	96	84
Cuts	8	16	8	12
Vibration damage	8	12	8	8

NB. Due to duplication and overlapping sources exceed 25.

Problems in mango business in retailer stage: The problems of the retailer are mainly transport, lack of storage and financial. 37-72% retailer opinioned about the lack of storage problem, 10-26% has the transport problem (Table 11).

Postharvest loss at retail level: Postharvest loss a retail level was highest in Mymensingh Sadar (11.48%) followed by Dhaka (8.80%) and Chapai Nawabganj (7.62%). Minimum loss (6.54%) was observed in Rajshahi Sadar (Table 12). Bruises, cut, vibration damage, microbial activity, lack of storage facility are responsible for this loss. The average amount of loss in retailer level was 8.63% in the surveyed areas. This result is in line with the findings of Sab et al. (2017). Murthy et al. (2002) reported a physical postharvest loss of 5.25% at retail level.

Table 11. Problem in mango business at retailers' level

Constraints	Chapai Nawabganj Sadar (n=25)	Mymensingh Sadar (n=25)	Dhaka (n=25)	Rajshahi Sadar (n=25)
	%	%	%	%
No problem	14	11	19	9
Transport	10	22	26	16
Storage	72	67	37	63
Others (Financial)	3	0	19	13

NB. Due to duplication and overlapping sources exceed 25.

Table 12. Postharvest loss of mango at the growers' level in the surveyed locations of Chapai Nawabganj, Mymensingh, Dhaka, and Rajshahi Districts

Locations	Chapai Nawabganj Sadar (n=25)	Mymensingh Sadar (n=25)	Dhaka (n=25)	Rajshahi Sadar (n=25)
Postharvest loss (%)	7.62	11.48	8.80	6.54
Minimum (%)	0	0	0	0
Maximum (%)	10	25	20	7.5
Standard deviation	3.52	4.22	4.87	2.55

Average postharvest losses of mango at different stages (growers', 'Bepari', wholesalers, and retailers): Losses of mango from harvest to retail sale were investigated in the present study. From this study it was found that around 30.65% of the produced mango and mango did not reach the consumers due to loss (Figure 02). This finding is in line with the finding of Sab et al. 2017. 4.40% postharvest loss occurs at the grower level. At the 'Bepari' level 8.44% loss occurs. The highest percentage of the loss occurred when the product goes to the wholesalers (9.21%) (Figure 02). The wholesalers brought their products from the 'Bepari'. In most cases, 'Bepari' purchase fresh produce from the growers, and they sale the produce to the wholesalers located at the destination markets at the cities. Wholesalers again transport their produce to different other places. For improper storage facilities both at the 'Bepari' and wholesalers' level and faulty transport, the loss possibly occurred at higher rates at the wholesalers' level.

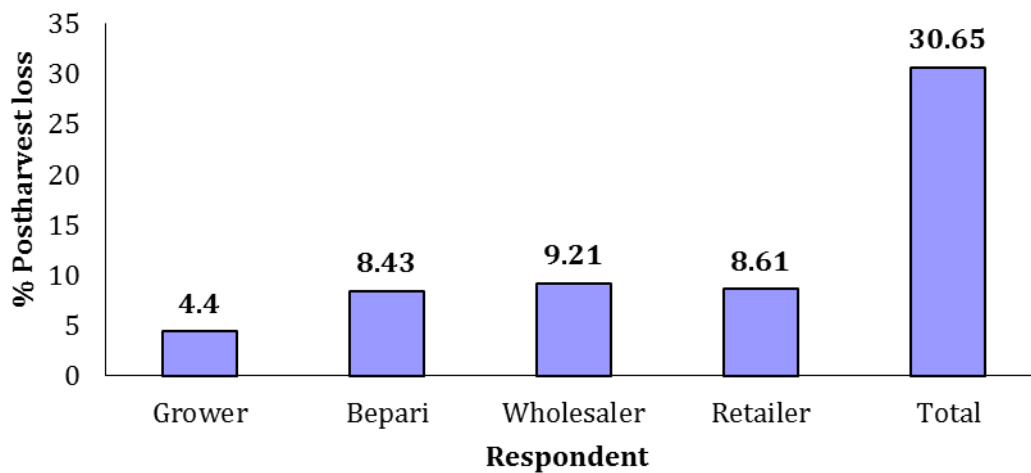


Figure 02. Postharvest loss of mango from harvest to sale in the retail market

Economic loss due to postharvest spoilage: The postharvest losses of mango were converted in terms of economic value. It was observed that annual loss of mango was 9.69 and 14.13 billion taka based on farmgate and retail prices, respectively (Table 13).

Table 13. Economic loss of fruits in harvest and postharvest stages

Fruit	Production (M. ton) (BBS, 2009)	Actual loss (%)	Farmgate price (Tk./kg)	Retail price (Tk./kg)	Total loss in billion taka based on farmgate price	Total loss in billion taka based on retail price
Mango	767000	30.65	41.22	60.11	9.69	14.13

IV. Conclusion

Considering the above stated findings, it may be concluded that losses of mango at the growers' level and at the subsequent postharvest handling steps were enormous. These losses result in two-folds social impact. Firstly, the country is facing enormous monetary loss. Secondly, the end users i.e. consumers are deprived from the nutrition's of mango. It is not possible to reduce the postharvest loss to zero percent but definitely a significant portion of the loss could be minimized and through these billions of taka of the country would be saved annually. The situation of postharvest management in Bangladesh is still sub-standard. Fast interventions should be taken to improve the present situation of postharvest management. Results of this study showed that 30.65% of the harvested mangoes do not reach the consumers. However, further studies are suggested to carry out for the confirmation of the above-mentioned findings.

Conflict of interest

The authors declare that they have no conflict of interest.

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