Consumers Behavior and Physiochemical quality assessment of Selective Street Foods Sold in Lucknow city

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ABSTRACT

For the urban dwellers of developed nations, street food plays a significant role in their daily life. They serve as a source of appealing, inexpensive, convenient, and frequently nourishing food for a wide range of people in society. While people of various social levels and all age groups eat street food, it is necessary to evaluate its quality. The present study aimed to assess the consumers behavior, physiochemical characteristics such as pH, T.S.S. Moisture content, morphological changes within the samples by S.E.M. and changes in structure by using x-ray diffraction technique, nutritional quality of 4 selective street foods i.e. panipuri, chola, chowmeen and samosa. The present study focused on 200 consumers and 4 selective street food based on most preferred by consumers who were randomly selected from different locations in Lucknow city. According to the results of the Chowmein, Samosa, Panipuri and Chole the highest fat values of 20.2, 19.46, 17.3 and 20.46 was found. Nutrient excess and Nutrient deficiency are both major health issues. Street food vendors need to receive training in nutritional security and standard operating procedures to ensure the quality of the cooked food and consumption. Other than that, in order to maintain the nutrient content of street food, vendors may be taught on the advantages of adequate nutrition through awareness training programmes. Promoting healthy eating practices and educating consumers about street food should receive more attention.

Keywords: Consumers Behavior, Street Foods, XRD, SEM-EDS, Physiochemical Parameters.

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1. Introduction

In developing nations, street food is a source of affordable, efficient, and frequently nutritive nourishment for both urban and rural impoverished people. The FAO describes street food as made and/or sold by vendors on the street from pushcarts, buckets, balancing poles, stalls, or stores with less than four permanent walls. Most people can physically and financially acquire street foods, which can be very helpful in meeting their basic energy and vitamin needs. In particular, the middle- and low-income populations who mainly rely on street foods have substantial nutritional implications for consumers, according to the FAO. The ingredients used, how they are made, stored, and sold, as well as how they are sold, determine the nutritional content of street food. Ingredients for street food vary by nation and are frequently illegal. Both the customer and the vendor have a sufficient opportunity to fulfil their daily nutritional needs at a reasonable price when they consume a variety of street foods. The nutritional value of street food must therefore be preserved through the development and application of appropriate technologies. The quantitative contribution of street meals to the dietary intakes of street food sellers or their customers, on the other hand, is far less well understood [1]. If every single nutrient were constantly monitored and protected, it would be a demanding effort because "nutrition" is a characteristic that is highly complicated and made up of a variety of endpoints. The typical way that food consumption is recorded is as a measurement of mass (grams) ingested, with this value occasionally being normalised to the intake of energy (calories/joules) [2]. While various studies have been carried out for children and adolescents of school age, little has been done regarding the food group intake habits of children aged 1 to 5 (preschool children) [3]. City dwellers' food consumption is influenced by a variety of unusual circumstances. The majority of foods are bought in the urban food industry. As a result, people require money to buy food. However, for the poorest, income-generating activities can be unpredictable and time-consuming. This in turn affects the ways in which people consume food. Although there is some evidence that undernutrition is less common in urban than in rural regions, mean undernutrition prevalences in cities conceal significant wealth gaps between the poorest and richest residents. For the majority of micronutrients, there are no statistics on their prevalence or sufficiency. Even if they are frequently better on average than in rural regions, urban areas' prevalences for micronutrient deficiencies are concerning when known [4]. This increased illness risk could be partially explained by changes in food habits. Increased consumption of fat, especially vegetable and edible oils, increased added sugar, increased animal-source foods, and decreased consumption of cereals and fibre, particularly coarse grains, staple cereals, and pulses are some of the generalised patterns of dietary change associated with nutrition transition [5]. For adults, the daily energy intake from street meals ranged from 13% to 50%, while for children, it was between 13% and 40%. Even at the lowest values of the percentage of energy intake range, energy from street meals made a sizable contribution to the diet, albeit the amounts varied from place to place. Furthermore, most research indicate that street snacks greatly increased daily protein intake. Because of the expected substantial contribution of street foods to overall dietary intakes of fat and sugar in various studies and their potential influence in the emergence of obesity and non-communicable diseases, dietary fat and carbohydrate intakes are of some concern [6, 7]. The prevalence of overweight and obesity among adults is currently estimated to be around 20 percent according to the most recent estimations. The three primary causes of death CVD, cancer, and other NCDs are 59, 15, and 16 percent, respectively [8]. Unhealthy eating patterns and nutrition-related practises, which are frequently based on a lack of information, cultural taboos, or a lack of understanding of the connection between diet and health, can have a negative impact on nutritional status [9]. Street foods made up the majority (78%) of students at Bogor University's total calorie intake, according to a study on total dietary consumption based on diary records [10]. Powder analysis of a sample Phase identification, sample purity, crystallite size, and, in some situations, shape are just a few of the critical details that XRD offers as a complement to different microscopic and spectroscopic techniques [11]. SEM/EDS is a commonly used elemental microanalysis technique that can identify and measure any element in the table [12]. SEM (scanning electron microscopy) has been widely utilised to analyse food components and finished goods. Historically, biological samples had to be chemically fixed and dehydrated to protect them from the abrasive conditions of electron microscopes. Secondary electrons released by the sample during SEM capture topographic data with a large depth of field. To describe the surface morphology of low moisture items, such as food powders or snack foods, conventional SEM has been used extensively [13]. Zn, O, Cu, Ag, and C may all be seen in the polymer matrix's EDX spectra and mapping images [14]. To be acceptable to consumers, prepared foods must have certain basic features. Food quality is influenced by changes in flavour, colour, preservatives, stabilisers, anti-oxidants, emulsifying and neutralising agents, and other ingredients. The presence of these food additives in manufacturing processes is frequently checked using a variety of analytical techniques, one of which is x-ray diffraction. X-rays can be utilised in diffraction, imaging, and scattering modes to check the quality of food. All of the techniques are robust, non-destructive, and have specific uses. For evaluating food quality and safety, x-ray imaging is a simple, quick method that is widely used in both food science and food production. The x-ray imaging system can be used to perform quality checks, including searching for foreign objects and minute particles and determining the density of food [15]. The structure of non-crystalline complex proteins and biomolecules is determined via X-ray scattering. The study's focus on XRD is its instrumentation and quality control/assurance in the bio-food industry. An easy and sophisticated non-destructive method for assessing food quality is x-ray scattering and diffraction. Although this method has been used for many years in the field of material research, it has only recently gained popularity in the field of food analysis [19]. The XRD method has been introduced as an effective way to explore many characteristics of materials at a nano-metric level as a result of the following expansion of the uses of x-ray radiations, as the x-rays' wave lengths are small enough to provide excellent resolution at atomic shapes and sizes [15]. By using proximate composition standards, which include moisture, ash, crude protein, fat, and carbohydrate content, the nutritional value of the street foods was evaluated twice. Also calculated were the total calories offered per 100g of the street food [17]. Depending on the molecular arrangement in the powder particle matrix, food powders can have an amorphous, crystalline, or mixed structure. The stability, usability, and applicability of powders in the manufacturing of food are significantly influenced by their structural makeup. Powders may unintentionally have an undesired structure during manufacture. In order to maintain product quality throughout storage and future processing, it is crucial to characterise the structure of the powder as well as quantify the amount of amorphous-crystalline pro-portions present in the powders [18]. Many methods have been developed to quantitatively and qualitatively analyse the structure of amorphous and crystalline powders due to differences in molecular mobility and arrangement. Scanning electron microscopes and X-ray diffraction are examples of prevalent approaches [18]. An associated increase in the consumption of processed foods, which are more likely to be high in fat, sugar, and salt and to be energy dense. Globally, the propensity for these bad eating behaviours to be more prevalent in LMIC may have contributed to the rise in non-communicable diseases (NCD), such obesity, during the past few decades. Specifically, CVD, cancer, respiratory illnesses, and diabetes account for 42, 10, 4, and 2% of all fatalities, making NCD the main cause of mortality. Despite the continuance of childhood undernutrition, there has been a continuous rise in overweight and obesity in recent years, especially in urban areas. The nutritional content of street food is unknown, and there hasn't been much research on it that isn't related to food safety and hygiene. Additionally, there is currently a knowledge gap regarding diet and nutrition studies, which has led to ignorance of the food supply and the dietary customs of this population [19]. Reformulation is described as altering a food's nutrient profile with the intention of making it healthier for consumers when used in the context of preventing NCDs. If implemented effectively, food reformulation procedures will increase dietary intakes by altering food composition without altering customer eating patterns [20]. The Codex Alimentarius has similar key goals for protecting consumer health, including as raising food safety, promoting healthy diets, and lowering the risks of

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chronic non-communicable diseases [21]. The quality of the street foods that contribute a significant amount of nutrients is also likely to decline [22]. Therefore, the objective of the present study was to characterise the street food, focusing on the street foods most preferred by consumers and available vending places and to describe the nutritional composition, Consumers Behavior and Physiochemical quality assessment of Selective Street Foods Sold in Lucknow city.

2. Material and Methods

The four selective street food samples were chosen on the basis of the most preferred by 200 consumers (mostly adolescents and adults includes) which are randomly selected and most viewed across all vending sites. This based on consumers eating behavior, criteria of food choice etc. In the beginning, Lucknow city was mapped by street walk to locate the locations of street food vendors. During the mapping process, it was discovered that the most popular street foods were Panipuri, chola, samosa, and chawmein (Fig. 1).

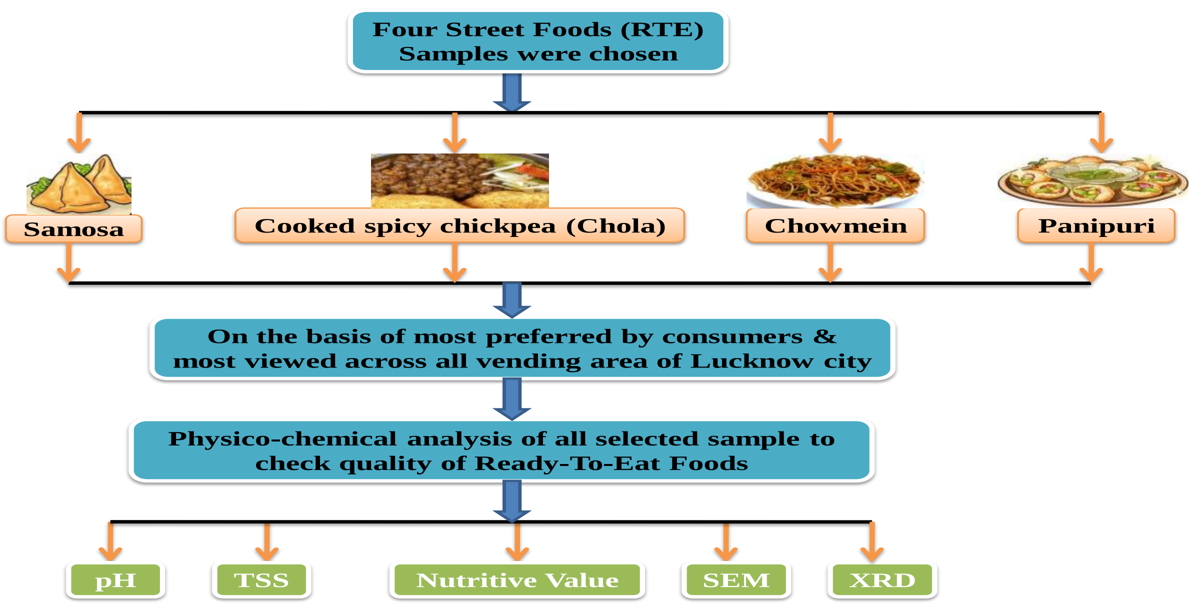

Fig. 1. Methodological overview

2.1 **Sample collection and processing:** The samples were collected as cooked spicy chickpea, samosa,

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chowmin and panipuri from the site. The samples were collected in pre-sterilized poly bags and carried to the laboratory for further analysis. Firstly all weighted samples sundry than dehydrate (Fig. 2) the sample. All dried sample was grind and prepare in the powder form.

Fig. 2. Food samples prepared in powder form.

2.2 Physiochemical analysis

2.2.1 pH: pH value of all samples was determined by using pH meter (Mini Digital Pen Style pH-Meter Set). For checking the pH value of selected street foods, chowmein, samosa, chola, panipuri were crushed and homogenized to make semi solid, and dip the pH meter electrode in a beaker (Fig.3) and take the record.

Fig. 3. pH value of samples determined by pH meter

2.2.2 Total Soluble Solids (T.S.S.): Using a hand refractometer (model MA 871, Germany), T.S.S. of each treatment was calculated and expressed in consistency after temperature correction at 18°. To ensure accuracy, the semi-solid sample CM, SS, CH, and PP was placed on a prism that had been cleaned with distilled water. The percentage of consistency of the semisolid component in the sample was then read at room temperature.

Fig. 4. T.S.S. value of samples determined by hand refractometer

2.2.3 **Nutritional Analysis:** All samples were homogenised, weighed, and kept in the freezer (-18°C) until nutritional composition analysis, after collection, which included the proximate analysis of (a) moisture by oven drying at 103°C until constant weight; (b) protein by the Kjedahl method with a conversion factor of 6•25; (c) fat by the Soxhlet method; (d) total minerals by dry ashing at 500°C; and (e) total carbohydrates, similar study in Albuquerque et al. 2020, Albuquerque et al. 2019, Hassan et al. 1991, Musaiger et al. 2008.

a) **Total Moisture:** Take the weight of blank crucible or Petri dish and then add 3 gm of the sample also measure the combined weight (W1). Now place the sample in oven for drying and this step is repeated till the constant weight is achieved (W2). Once the constant weight is obtained, stop the drying process and calculate the % moisture of the sample using formula:

$$\% \, Moisture = \frac{W1 - W2}{weight\ of\ sample} \times 100$$

b) **Ash content:** 3g of the sample was weighed into a crucible in a muffle furnace and heated at 550

◦C for six hours until it became gray ash. The dish was removed from the muffle furnace using crucible tong (Fig. 4) and placed in a desiccators to cool. When cooled it was re-weighed and the weight of ash was obtained by the difference. The ash percentage was calculated based on the following relation:

$$\% \, Ash \, (dry\ basis) =$$

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$$\frac{Weight\ of\ ash}{Weight\ of\ sample} \times 100$$

Fig. 4. Ash content determined by muffle furnace

c) **Fat content:** 3 gm of sample was taken and put it into the thimble, then weigh the sample along with the thimble (W1) Thimble was placed in the conical flask (Fig. 5) and the flask was filled with 50 ml petroleum ether and placed in water bath and allow the petroleum ether to boil. Continue the extraction process for 1 hour at 60-65◦C. Place the thimble containing sample to air dry it. Again take the weight of thimble (W2). The % Crude fat was calculated based on the following (AOAC,1990) [25] relation:

$$\%Crude\ fat =$$

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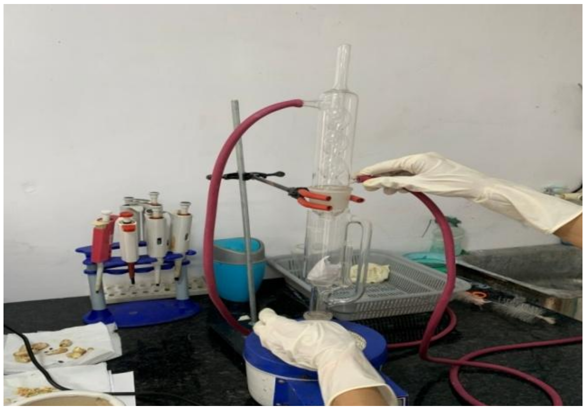

$$\frac{W1 - W2}{weight\ of\ sample} \times 100$$

Fig. 5. Determination of fat content

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d) Estimation of Protein content:

The protein content of samples was estimated by the Kjeldahl method, where the sample was kept for acidic digestion followed by neutralization and finally the titration. 2.5gm of samples was introduced in digestion flask and to that 10 ml of concentrated H2SO4 and 2.5gm of digestion mixture of K2SO4:CuSO4: Na2SO4 (equal ratio) was added. The flask was swirled in order to mix the contents thoroughly placed on heater to start digestion till the mixture become clear (blue green in color). It took 3hours to complete the process. The digest was cooled and transferred to 100 ml volumetric flask. The volume was topped up to mark using distilled water. Then from those ten milliliters of the digest was introduced in the distillation tube where 10 ml of 0.5 N NaOH was gradually added. Distillation continued for 10 minutes and NH3 (Ammonia gas) produced was collected as NH4OH (Ammonium hydroxide) in a conical flask containing 20 ml of 4% boric acid solution with a drop of modified methyl red indicator. During distillation yellowishcolour appeared due to NH4OH. The distillate was then titrated against standard HCL solution of 0.1N concentration till a pink colour observed. At this step the initial and final reading were noted to calculate the amount of titrant used and noted as Vs. A blank was also run as previous to the sample and for the blank nitrogen content of acetanilide or tryptophan after addition of 1 g of saccharose was determined at the titration step and the volume of titrant used was noted as Vb. The %N in sample was calculated via the given formula followed by the calculation of % P by multiplying the %N with the protein factor (PF) that is 6.25.

$$\%N = \frac{Vb - Vs \times n \times f \times M(N)}{m \times 10}$$

Where,

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Vs- volume of titrant used for
sampleVb- volume of titrant used
for blankn- Normality of Titrant =
0.1N
f-Acid Factor of = 1
M(N)- Molecular weight of Nitrogen =
14.007g/molm-

Sample weight = 2.5 gm

%N- % weight of N

$$\%P = \%N \times PF \text{ x DF}$$

Where

PF -6.25

DF = 10 (100/10)- Amount used for titration out of digested sample

e) Total Carbohydrate

Total Carbohydrate was calculated by Subtraction method. Sum of Moisture, Ash, protein and fat were done and deducted from 100 and expressed as percentage of total carbohydrate in the sample.

2.2.4 SEM (A scanning electron microscope)

SEM is a type of electron microscope that produces images of food particles (powder) by scanning their surface with a focussed electron beam. It is used to examine the morphology of food particles. The interactions between electrons and atoms in the particles result in a variety of signals that reveal details on the morphology and composition of the food particles.

EDX (Energy Dispersive X-Ray Analyse): Food particle elemental identification and quantitative compositional data are provided by EDX (Energy Dispersive X-Ray Analyse). The image, which was captured in representative areas of the tested material, was examined under high magnification.

2.2.5 XRD (X-ray Diffraction)

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Crystal polymorphism and the fraction of crystalline and amorphous material can be studied using X-ray diffraction data. The area under the crystalline peak and the area under the total diffractograph are commonly used to determine crystallinity. The crystalline polymorph, on the other hand, is characterised by the position of the peak at a certain 2. The incident X-rays are passed through at a tiny angle, the scattered pattern is captured in SAXS, and the diffracted data is acquired in XRD for further analysis. The diffracted/scattered X-rays obey Bragg's law, as illustrated below.

$$n\lambda \,¼\, 2d \sin\theta$$

where n is a positive integer, is the incident X-ray wavelength, d is the lattice spacing, and is the scattering angle. Although both XRD and SAXS follow Bragg's rule of diffraction, the latter is recommended for biological macromolecules, whereas XRD is primarily employed to discover crystalline polymorphism in materials. (Purohit et al., 2019).

3 Results and discussion

3.1 Consumers behavior

Table 1 reveals that the almost of consumers (50%) were 13-19 years adolescents and 50% were above 20 years (adults). majority 48% of the consumers were preferred street food on the basis of taste and 20% consumers were preferred street foods on the basis of Large portion size, and only 12.5% consumers were preferred street foods on the basis of Cost. In addition, few consumers had been preferred street foods on the basis of Nutritional value (7.5%), Availability (4.5%), Preference (6.0%), Hygiene (1.5%).

Table.1. Consumers eating behavior

Age	Frequency	Percent
13-19 years adolescents	100	50.0
Above 20 years (adults)	100	50.0

Criteria	Frequency	Percent
Cost of the snack/meal	25	12.5
Availability	9	4.5
Preference	12	6.0
Large portion size	40	20.0
Taste	96	48.0
Nutritional value	15	7.5
Hygiene	3	1.5

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3.2 Most purchased street foods by the consumers: Figure 6 reveals that the almost majority of the consumers were most preferred street foods samosa, Panipuri, Chawmein and Chole bhature.

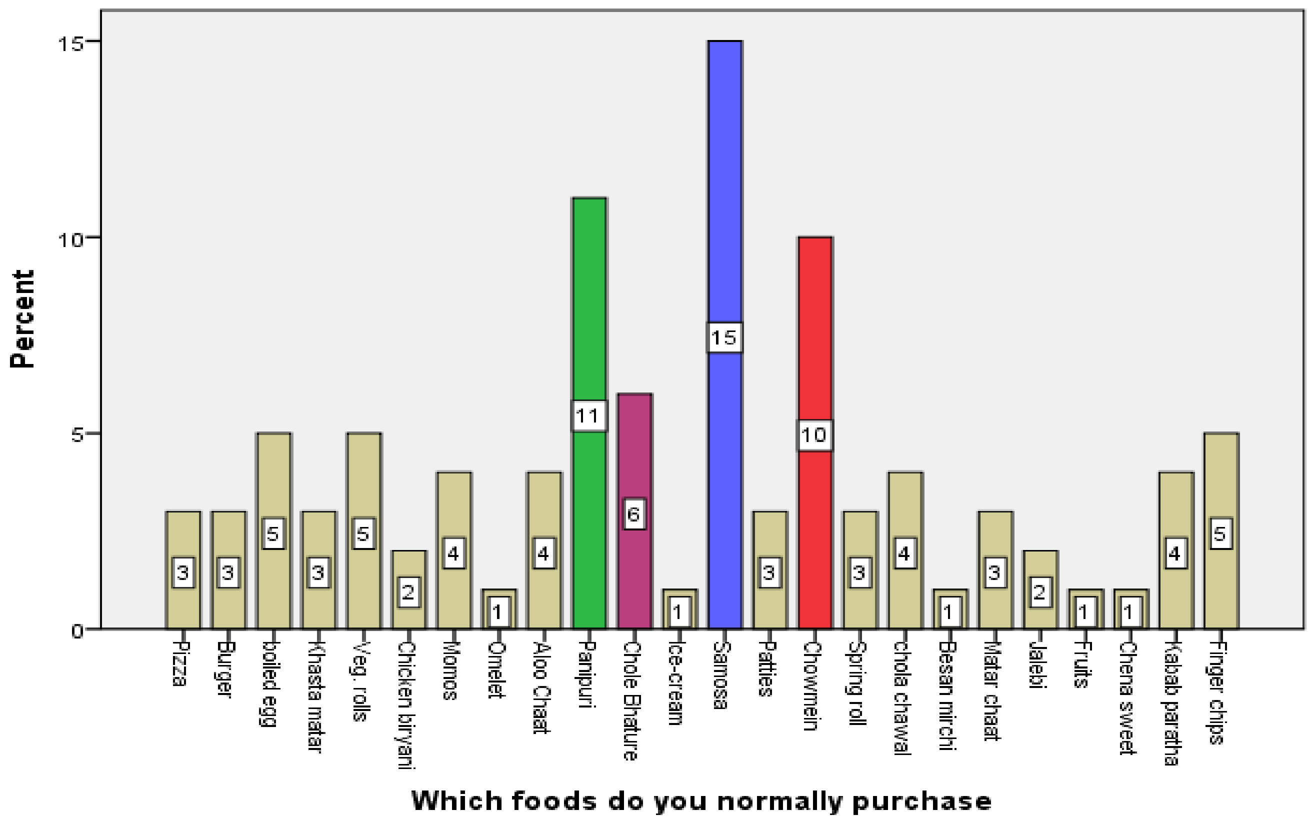


Fig.6. Consumers preferred street food.

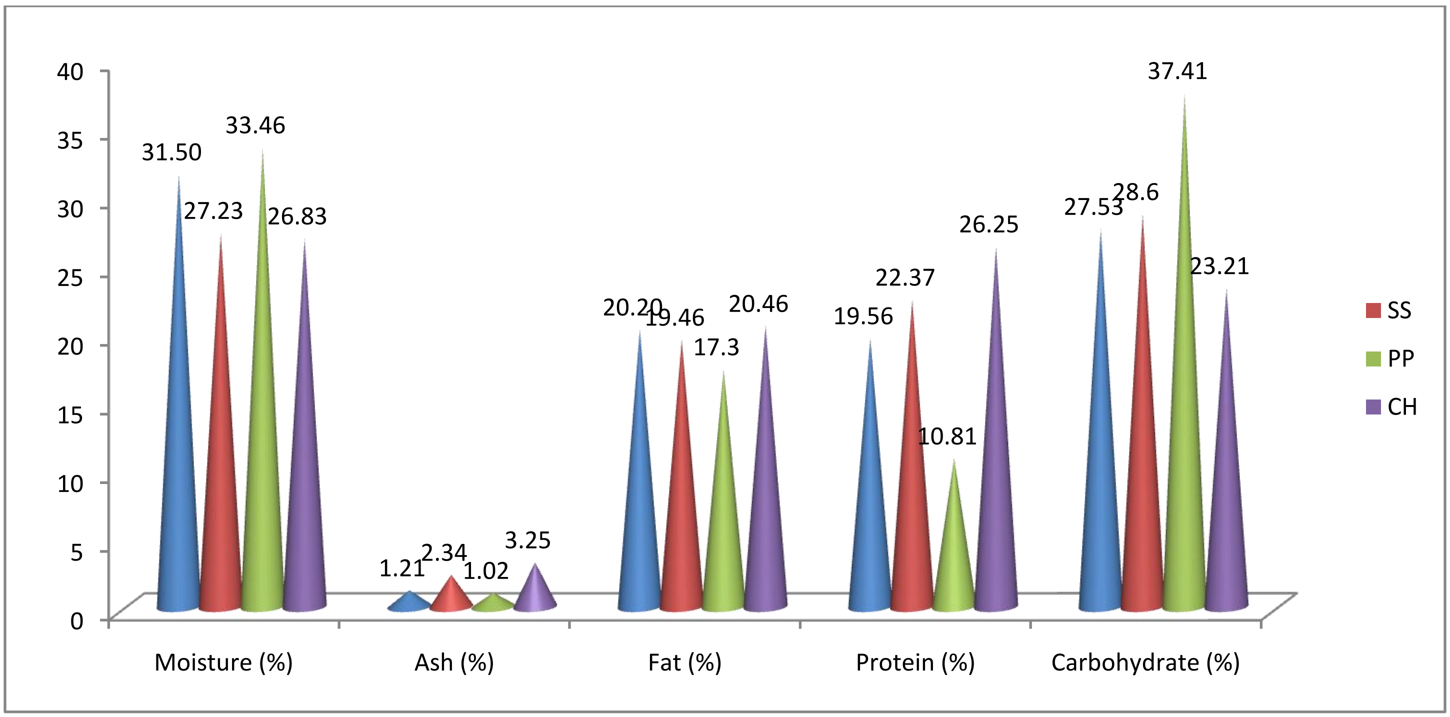
3.3 Physic-chemical analysis of street foods of most preferred by consumers.

The energy value of samples was estimated after proximate analysis of food components (moisture, protein, total fat and ash), performed in accordance with standard methods, as recommended by the Association of Analytical Communities. All the analytical results were the average of at least two determinations per food sample and were expressed by serving size (g). (Albuquerque et al. 2020, Albuquerque et al. 2019).

Table 2: Nutritional composition of Moisture, Ash, Fat, Carbohydrate and Protein in given food samples collected from street food vendors of Lucknow city

S. No.	Sample Code	pH	T.S.S.	Temp.	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Carbohydrate (%)
1	CM	5.26	0.0	21.3C	31.5	1.213	20.2	19.56	27.527
2	SS	**5.18**	**1.4**	**21.3C**	27.23	2.34	19.46	22.37	28.6
3	PP	**5.03**	**2.8**	**21.0C**	33.46	1.02	17.3	10.81	37.41
4	CH	6.04	4.8	21.4C	26.83	3.25	20.46	26.25	23.21

*CM: Chowmein SS: Samosa PP: Panipuri CH: Chole



CM: Chowmein SS: Samosa PP: Panipuri CH: Chole

Fig. 7. Estimation of Moisture, Ash, Fat, Carbohydrate and Protein in given fast food sample.

SEM images were used to study surface morphology and texture on the sample surface. Figures 8. (a, b, c, d) show the morphology of all dehydrated food samples such as CH, CM, PP, SS, respectively. At high

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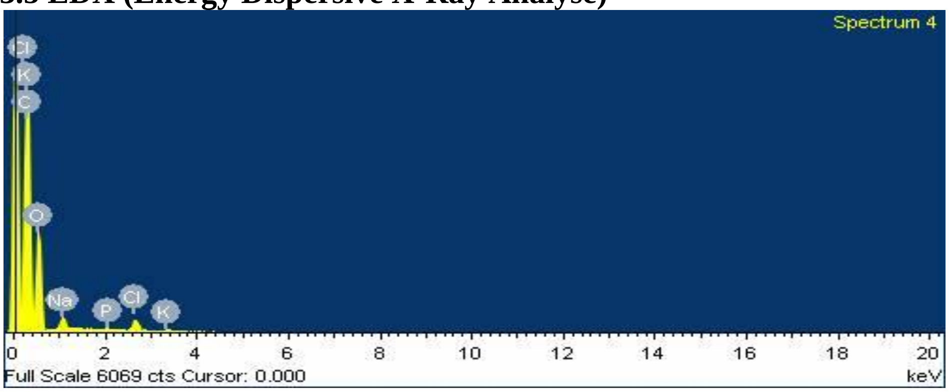
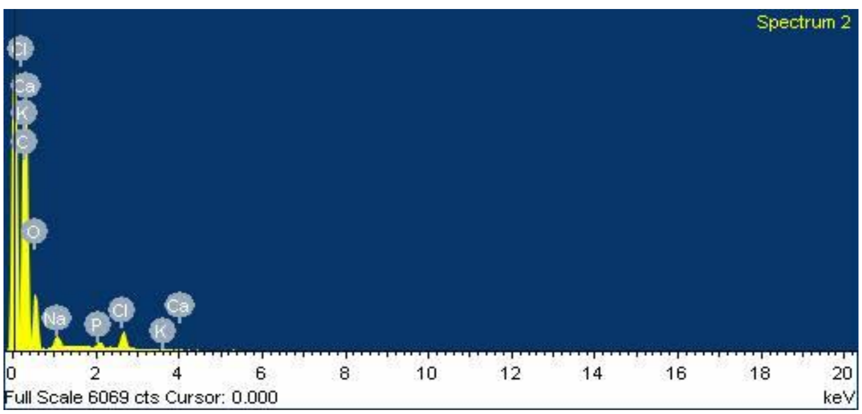
magnificent (×550) and at spectrum 3, 2, 5, 6 respectively, all figures a, b, c, d respectively, shows the deterioration of such quality attribute texture on the surface of the all food sample , the food particles disappearance led to homogenous phase or absence of air spaces inside. The irreversible loss of shape was, however, evident when using drying temperatures of 70 and 90 ºC for 4 to 6 hrs and some food particles were fused together. The drying temperature led to food particles becoming more shapeless, flattened and rough. Temperature significantly influences the morphology of food particles, so it is likely that other properties will also be affected **(Fazaeli et al. 2012).**

3.5 EDX (Energy Dispersive X-Ray Analyse)



Element	Weight%	Atomic%
C K	48.64	56.31
O K	48.74	42.36
Na K	1.40	0.85
P K	0.14	0.06
Cl K	0.90	0.35
K K	0.18	0.06
Totals	100.00	

(a) EDX graph and composition of CH food particles



Element	Weight%	Atomic%
C K	58.11	65.75
O K	38.35	32.58
Na K	1.54	0.91
P K	0.14	0.06
Cl K	1.64	0.63
K K	0.12	0.04
Ca K	0.10	0.03
Totals	100.00	

(b) EDX graph and composition of CM food particles

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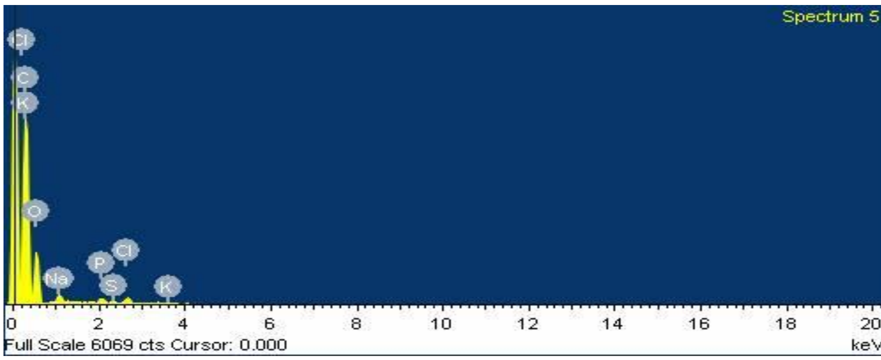
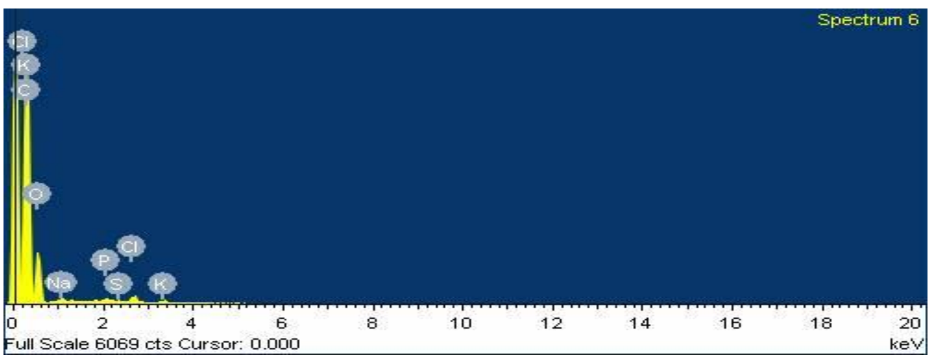


Element	Weight%	Atomic%
C K	56.03	63.54
O K	41.31	35.16
Na K	1.21	0.72
P K	0.40	0.18
S K	0.17	0.07
Cl K	0.67	0.26
K K	0.21	0.07
Totals	100.00	

(c) EDX graph and composition of PP food particles



Element	Weight%	Atomic%
C K	59.30	66.47
O K	38.92	32.75
Na K	0.52	0.31
P K	0.13	0.06
S K	0.11	0.05
Cl K	0.67	0.26
K K	0.33	0.11
Totals	100.00	

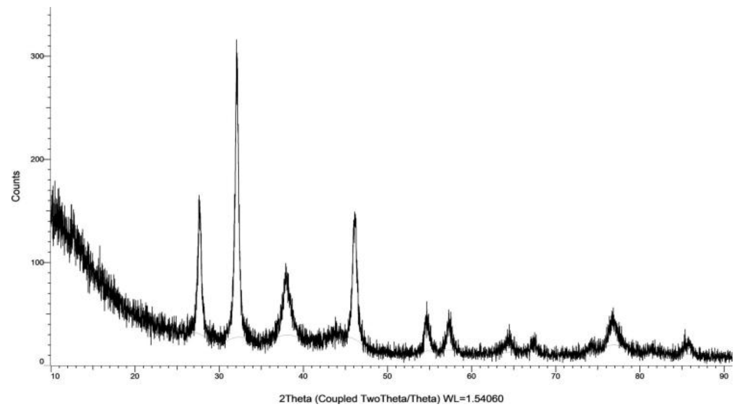
(d) EDX graph and composition of SS food particles

Fig.9. EDX (Energy Dispersive X-Ray Analyse) graph and composition of selective food particles; (a) CH, (b) CM, (c) PP, (d) SS. (Note: CM: Chowmein SS: Samosa PP: Panipuri CH: Chole).

Figure 9 (a, b, c, d) indicate respectively, the Energy Dispersive X-Ray analysis of CH, CM, PP, SS food particle and indicates that the particles were nearly about stoichiometry. In CH sample the weight amount of C determined by EDX was 48.64 and O was 48.74. Oxygen in the samples had a greater ratio than that of Carbon. The EDX spectra also showed the presence of other elements, such as Na, P, Cl, and K. In CM sample the weight amount of C determined by EDX was 58.11 and O was 38.35. Carbon in the samples had a greater ratio than that of Oxygen. The EDX spectra also showed the presence of other elements, such as Na, P, Cl, K, and Ca. In PP sample the weight amount of C determined by EDX was 56.03 and O was 41.31. Carbon in the samples had a greater ratio than that of Oxygen. The EDX spectra also showed the presence of other elements, such as Na, P, S, Cl, and K. In SS sample the weight amount of C determined by EDX was 59.30 and O was 38.92 with very less impurities. Carbon in the samples had a greater ratio than that of Oxygen. The EDX spectra also showed the presence of other elements, such as Na, P, S, Cl, and K. The EDX spectra only contained a little amount of impurities. The majority of the material is carbonaceous/organic compounds, as shown by the high carbon and oxygen content, whereas the remaining elements suggest that there are several inorganic minor/trace components, Similar study in Niemeyer 2015; Patel et al 2022.

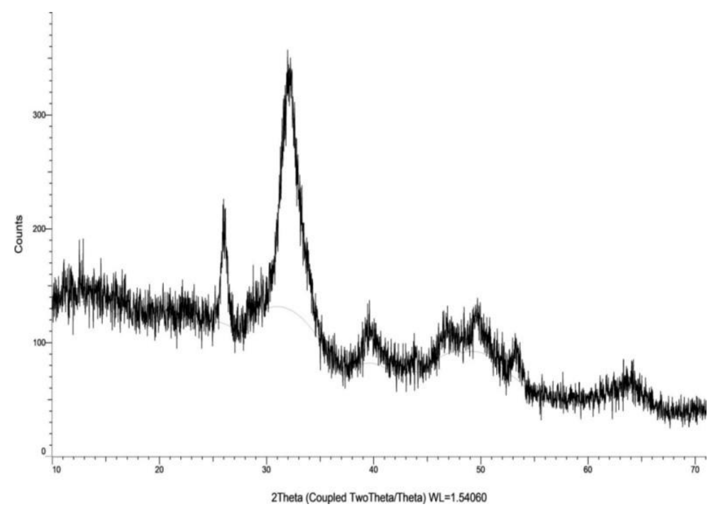
3.6 XRD (X-ray Diffraction) :

(Coupled Two Theta/Theta)



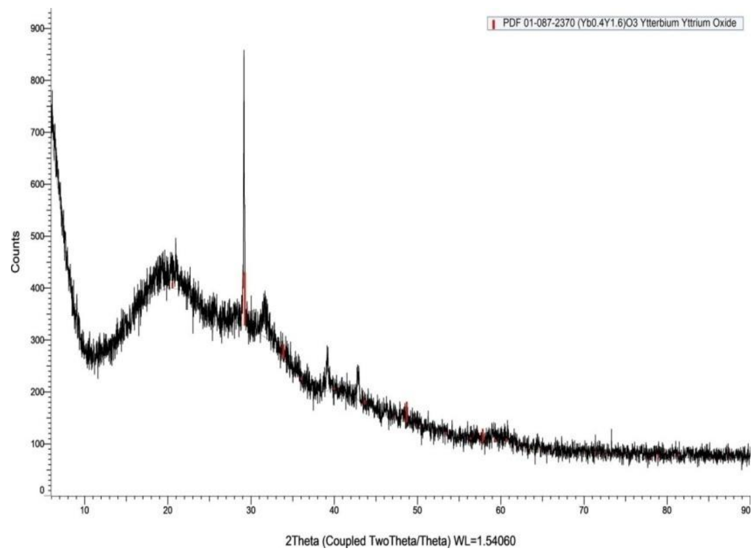
(a) XRD Pattern of CH.

(Coupled Two Theta/Theta)



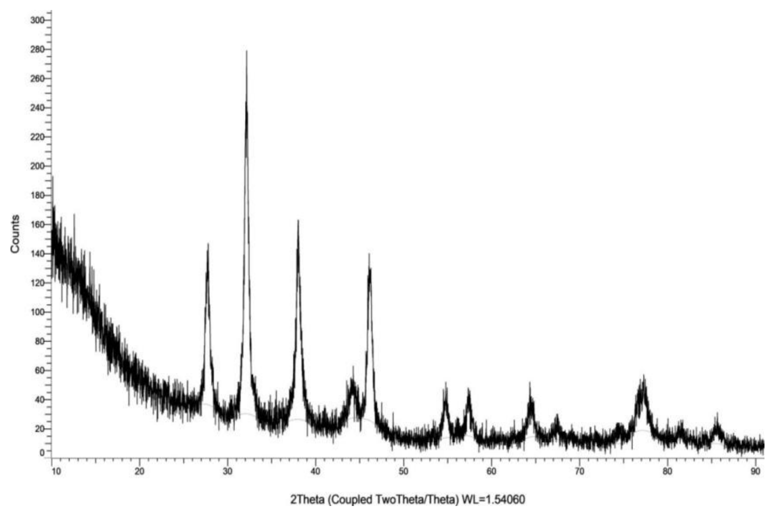
(b) XRD Pattern of CM.

(Coupled TwoTheta/Theta)



(c) XRD Pattern of PP.

(Coupled TwoTheta/Theta)



(d) XRD Pattern of SS.

Fig.10. XRD (X-ray Diffraction) pattern of selective food particles; (a) CH, (b) CM, (c) PP, (d) SS.
(Note: CM: Chowmein SS: Samosa PP: Panipuri CH: Chole)

Analytical techniques such as X-ray Diffraction (XRD) were used to characterise distinct selected food particles. XRD is used to determine the phase of a crystallinity-containing sample. It also provides information on the dimensions of unit cells. Based on Bragg's law, which connects the wavelength of radiation with the

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diffraction angle and lattice spacing in crystalline samples, the homogeneity and bulk composition are determined. The crystal structure and size of all food-particles were analysed by XRD. The crystalline nature of the food particles is indicated by the prominent peak of Figure 10 and. The atomic or molecular structure of particles was determined using X-Ray Diffraction Analysis or X-Ray Crystallography, in which crystallised atoms cause an incident X-ray beam to diffract in a variety of distinct directions. The crystal structure of all food-particles has been showed in Fig.10 (a, b, c, d) respectively, at CuKα (λ = 1.54060 A) in the Bragg reflection 2θ range. Sizes of the crystallite particles were calculated using **Bragg's** equation.

Bragg's law: $n\lambda = 2d \sin \theta$

where n is the positive integer, λ is wavelength of incident X-ray, d is lattice separation, and θ is the scattering angle. From the peak width and counts the small particle size and better crystallinity can be easily seen in Figs.. The higher counts peaks in XRD pattern was observed at 2θ- 59.643, 59.658, 59.965 in CH sample. These higher peaks observes at higher counts16.0. The higher counts peaks in XRD pattern was observed at 2θ- 59.637 in CM sample. These higher peaks observes at higher counts 58.0. The higher counts peaks in XRD pattern was observed at 2θ- 59.730, 59.975 in PP sample. These higher peaks observes at higher counts 130. The higher counts peaks in XRD pattern was observed at 2θ- 59.903 in SS sample. These higher peaks observes at higher counts 19.0. This peak which indicates the presence of V-type crystallites. This might be attributed due to the amylose–lipid complex formation during hydrothermal operation. The diffractogram of food samples revealed prominent peaks at diffraction angles of 16.0, 58.0, 130, and 19.0 degrees. The diffractogram of food particles revealed low prominent peaks at diffraction angles of 6.00, 42.0, 86.0, and 6.00 counts, albeit these peaks were underdeveloped. The increased impact of frying on oil has a negative impact on its physicochemical and microbiological characteristics. The diffraction pattern of extruded food particles shifted to the V-type pattern as opposed to the A-type pattern, which is indicative of food particle starches, indicating a decrease in starch crystallinity. The development of diffraction peaks at reflection angles of 7 and 13 degrees revealed the presence of V-type patterns in the extruded flour. V-type starches are generated as a result of amylose complexing with other substances such as lipids during hydrothermal treatments or high temperature processing. The aforementioned approach avoids the time-consuming sample preparation methods for XRD, such as dehydration and powdering of samples, as well as post-processing analysis. such as mathematical peak separation procedures for crystallinity measurement, similar study in Purohit et al. 2017, Moretti et al. 2020; Nawaz et al. 2018; Shakiba et al. 2017; Mangolim et al. 2014.

pH value of all samples was determined by using pH meter, and the pH value of selected street foods, chowmein, samosa, panipuri, and chola were (Table 2) recorded 5.26, 5.18, 5.03, and 6.04 respectively. **TSS value** of all samples was determined by using hand refractometer, and the TSS value of selected street foods, chowmein, samosa, panipuri, and chola were recorded (Table- 2) at room temperature 0.0, 1.4, 2.8, and 4.8 respectively. The fat content was 20-32%, while the energy content was 180-290 kcal. The two samples with the highest fat values were 32% and 31.33%, while the others were 24.84, 28.42, 20.83, and 23.62%, respectively. During the examination of Panipuri, the highest fat values of 15.75, 13.00, and 12.00% were discovered. Though the fat values obtained appear to be lower than those obtained from Samosa samples, they are higher in the case of Panipuri. The majority of the merchants utilised vanaspati ghee with frying oil. As a result, it had a high fat content and was thought to be an excellent source of energy, but it was quite concerned about health issues. Its consumption should be restricted because it may cause health concerns, similar study in Gawande et al. 2013; Kaushik et al. 2011, Verma R. et al. 2022, Verma R. et al. 2020, Mishra S. 2004, Verma R. et al. 202. In the present study, The average moisture content (Fig. 7) of Chowmein, Samosa, Panipuri and Chole was 31.5g/100g, 27.23g/100g, 33.46g/100g, and 26.83g/100g of sample. The average ash, fat, and protein content of Chowmein, Samosa, Panipuri and Chole samples was 1.213, 2.34, 1.02 and 3.25g/100g (ash), 20.2, 19.46, 17.3 and 20.46g/100g (fat), and 19.56, 22.37, 10.81 and 26.25g/100g (Protein) respectively. The average carbohydrate content of Chowmein, Samosa, Panipuri and Chole was 27.527g/100g, 28.6g/100g, 37.41g/100g, and 23.21g/100g. The average calories provided by 100g of Chowmein, Samosa, Panipuri and Chole were 527 Kcal, 262 Kcal, 180-215 Kcal, and 180 Kcal. Samosas, pani puris, chawmein and chole bhature are a few examples of popular street cuisine. The amount of calories and fat in Indian street cuisine depends on the cooking technique. The majority of street food in India is made by deep-frying in fat. Consuming a diet that is high in calories, sugar, and fat might cause consumers (adults, adolescents) to develop obesity, hypertension, dyslipidemia, cardiovascular illnesses, and impaired glucose tolerance at a young age.

4 Conclusion and recommendations

The current investigation concluded that all of the selected street items had good physio-chemical quality and nutritional composition. The street food sector plays a significant role in supplying the food needs of urban people in many developing-country cities and towns. The industry feeds millions of people every day with a diverse range of low-cost and conveniently accessible foods. However, both nutritional insufficiency and nutrient overload are serious health problems. Aside from that, very few studies on the physicochemical quality and nutritional content of street food have been discovered. Removing street food vendors is both impractical and immoral because they provide diversity and have become an integral part of Indian culture. Instead, we should strive to increase the nutritional content of the food they provide. Their low education levels are linked to poor sanitary practices in food handling and storage, which increases the danger of street food contamination and hence affects nutrition quality. Examination of street food by regulatory agencies and random examination of street food in nutrition labs to ensure the nutritional quality of street food sold by vendors. For the quality of the cooked food and consumption, street food vendors must be trained in nutritional security and Standard Operating Procedures. Other than that, sellers may be educated to the benefits of enough nutrition through awareness training programmes in order to maintain the nutritious quality of street food. More focus should be placed on promoting healthy eating habits and educating consumers about street food.

Authors' contributions

R.V. and S.M. wrote the main manuscript text and R.V., S.M., M.A.F. prepared tables 1-2, figures 1-6. All authors reviewed the manuscript.

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Declaration of competing interest

The authors declare that there is no conflict of competing interests.

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