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Evaluation of *In vitro* Binding Capacity of Viscose Fibers to some Minerals

Hamid Reza Hemati Matin and Farid Shariatmadari

Department of Animal Science, Faculty of Agriculture Tarbiat Modares University, Tehran, Iran

Abstract: This study was carried out to evaluate the binding capacity of different minerals with viscose fibers under *In vitro* condition. The pectin and carboxymethyl cellulose were used as substrate models of viscose fibers and sequential simulated physiological conditions of the gastrointestinal tract (GIT) method was employed. The results of current study showed that the treatment of fibers with simulated gastric condition made the fiber so viscous that it could not pass the filtration. The present study showed that this method is not successful for viscose fibers and it is recommended to use other techniques for immediate liquidation of viscose fibers and determination of its binding capacity to minerals.

Key words: Viscose fiber · Binding · Mineral · *in vitro*

INTRODUCTION

Fibers have positive effects against the incidence of a wide range of Enteric diseases [1], diets dilution, plasma lipids reduction, diverticulosis [2], cardiovascular diseases prevention, encourage normal laxation [3] and reduce pathogenic agents. The recommendations to increase fiber intake and addition of fiber to diets of monogastric animals has arisen some questions about its possible negative effects on the bioavalability of the essential elements. The fiber properties (cation-exchange capacity; proteins, phytic and uronic acids) [4, 5], functional groups, type and concentration of fibers, components of diets [6] and used methods to determine the binding capacity [7] may influence the obtained results. Different methods are available. The most common method, to determine the binding capacity of material under simulated GIT conditions, is incubation of added minerals to the fiber then centrifugation and the analysis of supernatant for mineral binding [8]. In this method it is assumed that recovered unbound minerals will be found in supernatant, this is previously mentioned by Rockway [7] who introduced a process for estimation of the bound–minerals by calculating the difference between the added and recovered minerals in supernatant. Various methods was developed and used for studying the binding capacity of various minerals with viscose fibers under *In vitro* condition such as the equilibrium dialysis [9], potentiometric [10] and the column chromatography [11] in the light of the method of Idouraine *et al.* [12].

MATERIALS AND METHODS

The carboxymethyl cellulose was prepared from J. Rettenmaier R and Söhne GmbH+Co and pectin was prepared from HP, USA. The carboxymethyl cellulose and pectin were used as substrate models of fibers.

Viscosity Measurement: The viscosity of 0.1% (w/v) fibers solutions was determined at 25 °C by viscometer (Brookfield, LD) which previously calibrated with silicone standard.

***In vitro* Mineral Binding Capacity (Sequential Simulated Physiological Conditions):** The *In vitro* mineral binding capacity of the viscous fibers was studied under sequential simulated physiological conditions of GIT according to Idouraine *et al.* [12]. As briefly 25 g of carboxymethyl cellulose and pectin gently shake in1% HCl solution for a period of 3 h at 37 °C to mimic stomach condition. Subsequently, the obtained slurry filter through a Whatman 541 ash less filter paper and the residue is washed several times with ultrapure water. All gastric conditions treated fiber samples were freeze-dried and fractions of 4.5 g were kept for analysis of minerals.

Corresponding Author: Hamid Reza Hemati Matin, Department of Animal Science, Faculty of Agriculture Tarbiat Modares University, Tehran, Iran. Tel: +98 3179379.

To determine the mineral binding under conditions of the small intestine, a portion (4 g) of each previously treated fiber sample separately mixed with 40 mL of standard solution (1000 mg/L) for each mineral. The volume of the mixture must then made up to 400 mL by addition of the 2.0 mM MES buffer solution and incubated at 37 °C for 3 h. The slurry then centrifuged at 2500 g for 15 min under 25 °C. The supernatant was discarded and the residue washed several times with ultrapure water then, each small intestine condition treated fiber samples freeze-dried and portions (1.5 g) were kept for the minerals analysis. Finally, to determine the mineral releasing capacity under conditions of the colon portions (2 g) of the mineral-bound fiber treated with simulated small intestinal physiological conditions was incubated with the 2.0 mM MES buffer solution for 24 h at 37 °C. The slurry was centrifuged as mentioned above and the residue was washed several times with ultrapure water. All treated fibers by colonic conditions then freeze-dried and portions (1.5 g) were kept for the mineral analysis.

RESULTS AND DISCUSSION

The results of viscosity values for carboxymethyl cellulose and pectin are shown in Table 1. The viscosity of carboxymethyl cellulose (11.8 cP) and pectin (6.14 cP) are substantially high. This measure indicated that one can put them to category of viscous fibers. The fiber viscosity depends on the solubility, molecular weight, structural chemical bonds, molecule size, spatial shape and concentration [13]. The current study traced the same findings where the solubility, molecular weight, spatial shape and structure linkage may cause difference in fibers viscosity. They cause simple viscosity at low concentrations, but they form severe viscosity at high concentrations in contact with water. Moreover, it is showed that β 1-4 glycosides linkage in the structure of fibers led to an increase in their viscosity [4]. In fact, the spatial structure of carboxymethyl cellulose and pectin are hydrophilic and forming gel like material and increase the viscosity of prepared solutions.

Table 1: The Viscosity properties of fibers

Material	Viscosity[1] (cP)
Pectin	6.14 ± 1.14
Carboxymethyl cellulose	11.8 ± 0.79
SEM	0.313
P Value	< 0.0001

1- Viscosity 0.1 % (w/v) solution at 25° C.

On the other hand, the results of binding mineral capacity to fibers showed that in the step of slurry filtration through a Whatman 541 ash less filter paper after fibers treatment with simulated stomach conditions due to the high viscosity and gel forming by fibers the examination did not continue and the methodology faced problems. The fiber viscosity was as high as it could not pass through the filter paper as matched with measured viscosity (Table 1). When this obstacle was happen, modulations and different ways were tested to overcome to problem. The method of experiment was repeated twice to ensure from problem, obtained slurry was diluted more times to reduce fibers concentrations and facilitate its passage from filter paper, filter papers was changed, filtration was done by more force but none of them was helpful and didn't get any results in this respect. Therefore, it appears that this method is not suitable for viscous materials to assay mineral binding capacity.

CONCLUSION

It is concluded that the use of sequential simulated physiological conditions of GIT technique [12] to determine the mineral binding capacity of the viscous fibers (carboxymethyl cellulose and pectin) is not successful and it is recommended to use other methods.

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