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Research Article

Camel Milk-Clotting Using Plant Extracts as a Substitute to Commercial Rennet

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The transformation of camel milk into cheese is an operation considered very delicate because of several difficulties encountered in achieving coagulation. The present study aims to improve coagulation abilities of camel milk using enzyme extracts from pineapple, kiwi, and ginger. Our results concerning the characterization of the enzymatic extract showed an extraction yield that varies according to the type of extract (pineapple: 75.28% ± 4.59, kiwi: 63.97% ± 5.22, and ginger: 28.64% ± 1.47). The optimum coagulation conditions of the 3 types of extract were as follows: for pineapple: pH = 5 and temperature = 45°C; for kiwifruit: pH = 6.6 and temperature = 40°C; and for ginger: pH = 6.6 and temperature = 45°C. A fresh cheese was made from camel milk with a particular nutritional quality and consistency. The kiwi proteases displayed chymosin-like properties and thus hold the best potential for use as a milk coagulant in cheese production.

1. Introduction

Camels (*Camelus dromedarius*) are of particular interest in arid and desert regions. Their unique adaptability makes this species ideal for exploitation facing the challenges of global warming and perfect allies for food security under changing climate. Camel milk is mainly consumed raw just after milking or fermented but rarely processed into cheese [1] due to a low amount of κ-casein [2]. Hence, several studies focused on the functional and coagulation properties of the camel milk's proteins [3–6]. In spite of the above difficulties, satisfactory cheese can be made when cheese-making procedures are adapted to camel milk's particular characteristics [7]. A lot of work was dedicated to improve coagulum formation process using various proteolytic enzymes obtained from animal, plant, and microbial sources.

In general, bovine chymosin is the most used enzyme in a cheese-making procedure. However, the availability of calf rennet has become limited due to the worldwide increase in cheese manufacture, coupled with the reduction in the slaughter of calves due to their low meat production, and has led to search for alternative milk-clotting enzymes, as appropriate rennet substitutes [8–10]. Proteases from plant sources offer a high potential as nonanimal rennet alternative in production of cheese, food (e.g., production of novel dairy products, meat tenderizers, and protein hydrolyzate production), and medicine (e.g., digestive and anti-inflammatory agents) [11, 12]. An increasing interest toward milk-clotting agents obtained from plants in cheese industry has been noticed because of their easy availability and simple purification processes [9, 13]. Furthermore, the use of plant proteases in cheese manufacturing promotes the greater acceptability by the vegetarians, some religious groups, and exigency of banning genetically engineered food [14]. For years, plant extracts have been used as milk coagulants in traditional cheeses which are mainly produced in Mediterranean countries, West Africa, and Asia [15]. Indeed, dried cardoon flowers of *Cynara cardunculus* L. and *Cynara humilis* L. have been used for centuries in the Iberian Peninsula to prepare certain varieties of cheese with a creamy soft-texture and exquisite flavor. The aspartic proteases cardosins and cyprosins (also