嘉南藥理科技大學專題研究計畫成果報告

具控釋效果之感溫型魚飼料研發

The Investigation of Controlled Release Fish Diet Containing Alginate and Thermo-sensitive Hydrogel

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主持人：林恆弘　　嘉南藥理科技大學 藥學系
計畫參與人員：張麗珍 嘉南藥理科技大學 藥學系
吳佩珊 嘉南藥理科技大學 藥科所

一、中文摘要

理想的魚飼料應是能提供均衡的營養與良好的食料轉換效率卻不會影響水質。本研究主要是嘗試採用魚飼料之藻酸鹽膜衣，在控釋包覆材料中添加感溫親水膠體來調節主成分的釋離，並使用兩種包覆方法進行膜衣包覆，而主成分自圓粒的釋離情形則以體外釋出試驗來探討。結果顯示，方法 A 是理想的製造過程，也就是含藻酸鹽的圓粒加入氯化鈣溶液中以形成控釋膜，其接觸時間越長則包覆膜的保護效果越好，但不影響最終粒徑大小。藻酸鹽包覆圓粒之主成分的釋離時間與藻酸鹽及可塑劑含量高低有關，魚飼料藉由藻酸鹽的包覆可提供遇水時的完整性甚至可持續 24 小時以上，倘若在包衣處方中加入 poly(N-isopropylacrylamide) (PNIPA) 為感溫型親水膠體，則所包覆之圓粒對環境溫度將具有刺激感應的性質。上述結果有助於爾後發展其他魚飼料控制釋放系統之參考依據。

關鍵詞：控制釋放，感溫性，圓粒，魚飼料

Abstract

Ideally, the fish feed that provide balanced nutrition and result in good feed conversion efficiency should not contaminate the water quality. In the present study, we attempt to investigate the alginate coating film by using thermo-sensitive hydrogel as the main components release regulator for the preparation of the controlled release fish diet. Two preparation procedures were carried out to coat the fish pellets. The release profile of the resulting pellets was investigated by *in vitro* release experiment. The results show that the ideal preparation process is method A, i.e. the pellets containing alginate were added into calcium chloride solution to form a film for controlling release. The longer contact time has the better protective coating properties, but didn't correlate with size of pellets. The component release duration of alginate coating pellets correlated with thickness of coating film and plasticizer content in coating film. The alginate film coating may protect the fish pellets and provide the pellets almost completely intact in the initial stage in water even lasting more than 24 hours. If the

formulation of coating film is added poly(N-isopropylacrylamide) (PNIPA) as a thermosensitive hydrogel, the coated pellets will be stimuli-responsive properties by environment temperature. The above results will be helpful to possible development of the other fish feed controlled delivery systems.

Keywords: Controlled release, Thermo-sensitive, Pellets, Fish feeds

二、Introduction

Aquaculture in Taiwan began more than 300 years ago. At present, aquaculture plays a very import role as a food industry in Taiwan and has risen into prominence throughout the world. (1) In order to promote maximum fish growth, it is desirable to feed the fish as much as they will eat. (2) However, overfeeding creates unnecessary cost and waste which leads to special problems such as water pollution or making fish more prone to diseases. (3) Many fish farmers use feeding behaviour as an indicator of appetite - so-called feeding response. Increased, vigorous activity when feed is introduced to fish indicates hungry stock, the response diminishing as more and more fish become satiated, i.e. their appetite demand is met. (4) Within modern aquaculture, a stocks' nutritional needs can be met using different types of diet depending on the stock being cultured and what life cycle stage is involved. (5) Irrespective of their main dietary requirements, the digestive systems of fish are very similar. (6) Thus the consumption of food and ensuring that dietary energy is maximised for growth and minimised for general daily expenditure may be more important than definitive levels of one particular nutritional component. Alginate, also called alginic acid or algine, is a sticky copolymer (or gel) substance found abundantly in the cell walls of brown algae. One advantageous property of alginate is in the ability to formulate controlled set gels by manipulation of the calcium ion availability. This can be used in cold whip products where the gel set is delayed by a few minutes until the alginate is dissolved. (7-9) In the present study, we attempt to investigate the alginate film by using thermo-sensitive hydrogel as the main components release regulator for the preparation of the controlled release fish diet.

三、Results and discussion

The pellet type of original fish feed was bought from market. The formulations used in the experiments are shown in Table 1. Alginate which was used as the film agent is nontoxic and biodegradable nature polymer. Two different procedures of encapsulation were carried out in the preparation of fish diet.

Method A : The accurate amount of fish feed pellet was immersed in a solution of sodium alginate of known concentration for 5 minutes with well stirring. And then the excess of sodium alginate solution was drained and the wet fish pellets were added into a solution of calcium chloride of known concentration. After an appropriate contact time, the pellets were filtered. The excess calcium chloride adhering to the surface of pellets was removed by washing them with water followed by air dried.

Method B : The accurate amount of fish feed pellet was immersed in a solution of sodium alginate of known concentration for 5 minutes with well stirring. Gelatin、PEG 6000 and Tween 80 were added respectively. A solution of calcium chloride of known concentration was then added with 5 minutes of contact time, the pellets were filtered and air dried.

The release profile of the resulting pellets was investigated by *in vitro* release experiment. The *in vitro* release of fish pellets was carried out in the 15-ml vertical Franz diffusion assembly. The apparatus was maintained at 37 ±0.5° C with a water jacket. An aliquot of the sample was taken at appropriated times, and the concentration was determined by UVmethod.

The results show that polymer's flocculation may suddenly occur during the coating process of method B as the calcium chloride solution was added into the mixture solution containing alginate. Hence, it is difficult to obtain a homogeneous coating film on the surface of fish pellets by method B. In regard to the property of coating film, method A is better than method B.

In method A, the external materials of wet pellets composed of alginate-gelatin hydrogel creating a well coating film surround the fish pellets, which was added into a solution of calcium chloride of known concentration. The longer contact time has the better protective coating properties, but there was no significantly different above 30 minutes. The size of pellets didn't correlate with the contact time. The resulting fish pellets went through with washing and air dried. In *in vitro* release studies, the alginate film coating suffered short mission life due to its brittleness, low mechanical robustness, and fast erosion rate in pH 7.0 buffer solution at 37 ±0.5° C environment. Sorbitol and PEG 6000 were added as the plasticizer in coating film materials to optimize the release profile of fish pellets. The addition of plasticizers that increase viscosity may be helpful before coating. The higher viscosity of alginate hydrogel solution may increase the thickness of coating film. The component release duration of alginate coating pellets correlated with thickness of coating film and plasticizer content in coating film. It can be seen that the alginate film coating may protect the fish pellets and provide the pellets almost completely intact in the initial stage in water. There is scarcely component release from pellets with lasting more than 24 hours. If the formulation of coating film is added poly(N-isopropylacrylamide) (PNIPA) as a thermosensitive hydrogel which was obtained from our previous studies, the coated pellets will be stimuli-responsive properties by environment temperature.

Table 1. Formulae of fish feed pellet product

Composition	Amount ratio (%,W/W)
Feed dried pellet	72.2~98.7

Sodium alginate	0~5.0
Calcium chloride	0~2.0
Gelatin	0~2.0
PEG 6000	0~2.0
Sorbitol	0~1.0
Tween 80	0~1.0
Total	100

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共同主持人：許立人

計畫參與人員：張麗珍

吳佩珊

執行單位：嘉南藥理科技大學 藥學系

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