CHAPTER I
INTRODUCTION

New packaging technologies have been continually developed to prolong and indicate quality of fresh, refrigerated, and processed foods. Especially, packaging may be termed active when it performs some roles in the preservation of foods other than providing an inert barrier to external conditions. Active Packaging is an innovative concept that can be defined as a mode of packaging in which the package, the product, and the environment interact to prolong shelf life or enhance safety or sensory properties, while maintaining the quality of the product. This is particularly important in the area of fresh and extended shelf-life foods. The active system can be an integral part of the package or be a separate component placed inside the package. Substances that can either absorb or release a special gas will control the internal atmosphere of the package. Other active systems slowly release the active substances onto the food surface. There are many examples of active packaging technologies including antimicrobial and antioxidant films, oxygen scavenging, ethylene absorbing, carbon dioxide absorbing and emitting, and ethanol releasing.

Polypropylene (PP) is a versatile thermoplastic polymer from the monomer propylene. It can be fabricated into packaging film that has good clarity, resistance to UV light, excellent chemical and abrasion resistance. Polypropylene film has fairly scuff resistance, good acid resistance, and has a fair heat resistance. Although polypropylene film has widely used for food packaging, but it does not have oxygen and moisture barrier property. This limits using polypropylene film in some fresh food packaging since it is not breathable. Adding micro perforation (a series of tiny holes punched in plastic film) into PP film is performed in order to use for biochemically active agricultural products such as fresh fruits, fresh vegetables, fresh herbs, and flowers, and more particularly for use in modifying the flow of oxygen and carbon dioxide into and/out of a fresh produce container.

Novel and efficient polymer materials for food packaging based on nanotechnology can provide innovative solutions to increase the performance of the polymers further adding safety, economical and environmental advantages, such as reduction to zero of any critical interaction with food matrices and with human health, reduction of the energy-inputs for production, transport and storage, increase of biodegradability and barrier protection to gases and light, reduction of volume of waste material to be disposed of inland fills, contribution to decrease carbon dioxide gas emissions. Although the large amount of researches being undertaken in industry and academia, polymer nanotechnology for food packaging is still in a development stage. There have been many researches using nanoclays to modify barrier property of the polymer material to gas and water. The nanoclay generally used is the montmorillonite (MMT), which modified montmorillonite has been obtained by substituting inorganic cations of MMT with organic ammonium ions in order to improve distribution in polymer matrix.

Microscale inorganic materials with well-defined morphology have attracted considerable attention for their structure characteristics endowing them with a wide range of potential applications. Among all metals, copper is the most commonly used as an interconnect due to its high electrical conductivity. Copper nanoparticles have exhibited extraordinary properties and have potential applications in several fields such as lubricants, catalysts, thermal transfer nanofluids, electronic materials, optical devices, and antifungal-antibacterial activities. There has also been evaluation to use low-copper loading in food packaging for antibacterial function. Copper nanoparticles have been prepared by wet chemical reduction, electrode discharge, photochemistry, sonochemical reduction, microwave irradiation, and gamma radiolysis. To avoid oxidation, these methods usually were performed in non-aqueous media, at low precursor concentration and under protection of inert gas. Wu *et al.* reported a one-step synthesis of pure copper nanoparticles in aqueous solution with ascorbic acid as a reduction agent and antioxidant as well. Polyvinylpyrrolidone (PVP) was used to help dispersion of colloidal solution and found that the ratio of [PVP]/[Cu^{2+}] played an important role in controlling the size, size distribution and morphology of the nanoparticles.

The retail food market in Thailand is changing rapidly; the number of shops handling a narrow range of foods is decreasing, while supermarkets and large self service stores are increasing in number and size. There is considerable scope for expanding the market for fish through these modern outlets, provided a good quality product is attractively presented for sale in a suitable package. Some large stores are selling wet fish from a traditional slab, with a fishmonger in attendance, but this method has a number of disadvantages; a large space is needed, the slab has to be manned continuously, the products are inconvenient to handle and there may be some smell and possibly contamination. In contrast, properly packaged fish products can be easily handled by nonspecialist staff, examined by the shopper for type, quantity and price, purchased and carried home in the shopping basket with other foods. Prepacked chilled fish have been sold for many years from frozen food cabinets containing other foods. Prepacking is mainly a method of presentation, not of preservation; the shelf life of a wrapped wet fish product is virtually the same as that of an unwrapped one. There is sometimes a small increase in shelf life, but not enough to justify keeping prepacked fish longer in the shop. The most useful materials for making small packages of chilled fish are the thin flexible films produced mainly from plastics such as polyethylene, polypropylene, and polyvinyl chloride. Chilled fresh fish requires the protection of a reasonably good barrier to water vapour to prevent it drying. Water vapour can pass through a film in two ways; the film may be porous so that vapour passes through holes in the material, or the film may be permeable, that is water vapour diffuses through it by dissolving in the material. Thin films are often porous, but porosity can be overcome by using a thicker film; however, a permeable film cannot be made impermeable in this way. Gases like oxygen or carbon dioxide for example are transmitted through a film in much the same way as water vapour.

Volatiles amines, such as trimethylamine (TMA), ammonia (NH_3) and dimethylamine (DMA) contribute to a quantity known as total volatile basic nitrogen (TVB-N), are the characteristic substances responsible for the fishy odour and flavour encountered in fish after having past the initial phase of freshness. TVB-N levels increase as a result of bacterial metabolism. In an enclosed food package, as the fish product spoils, a pH increase occurs over time within the headspace which can be detected with an appropriate pH indicating sensor. The fundamental characteristic of pH indicator dyes that change color when placed in an acidic or basic environment is the key element of this freshness indicator.

Mangosteen (*Garcinia mangostana* Linn., GML) is a fruit cultivated in tropical areas especially in Thailand, Malaysia, the Philippines and Indonesia. Experimental studies have demonstrated that extracts of GML have antioxidant, antitumoral, antiallergic, anti-inflammatory, antibacterial, and antiviral activities. The pericarp of GML is a source of xanthones and other bioactive substances. Prenylated xanthones isolated from GML have been extensively studied; some members of these compounds possess antioxidant, antitumoral, antiallergic, anti-inflammatory, antibacterial, antifungal and antiviral properties. Xanthones have been isolated from pericarp, whole fruit, heartwood, and leaves. The most studied xanthones are α-, β-, and γ-mangostins ($C_{20}H_{22}O_5$), garcinone E, 8-deoxygartanin, and gartanin. Moreover, a substantial amount of red pigment, mainly are cyanidin-3-sophoroside and cyanidin-3-glucoside can be isolated from the fruit pericarp of mangosteen. Their color can change with pH; solutions of the compound are red at pH < 3, violet at pH 7-8, and blue at pH > 11. The red pigment from the fruit pericarps of mangosteen can be used as a natural dye source for dyeing, with associated benefits in use with respect to reduced health hazards, lower toxicity and allergic reactions. There have been a few reports attempting to use mangosteen dye extraction in food packaging.

This research is aimed to develop an active packaging film made of polypropylene containing antimicrobial substances and feasibly detects spoilage in fresh fish. Bentonite organoclay and copper nanoparticles were added into polypropylene for barrier properties and antimicrobial activities. The impact of these nanoparticles on clarity, mechanical and thermal properties of the nanocomposite blown films was investigated. Natural dye (dark red) from mangosteen pericarps extracted in aqueous acidic solution was also studied its feasibility to be used as indicator dye for sensing ammonia gas and fish spoilage.