ULTRASTRUCTURAL RESEARCH OF STARCH GRANULES AND STARCH SAUSAGE

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INTRODUCTION

Starch is widely used as an extender in sausages in China, as we know, it contributes much to the carbonhydrate content. However there have been few reports concerning its effects on the physical, chemical and flavouring characteristics of sausages.

Starch granules of two types(potato and corn)were studied by scanning electron microscopy(SEM)before and after heated to different temperatures in water. In addition, sausage were made with the mixture of starch and pork, starch being as an extender. Samples were taken from different parts of the sausage, freeze-fractured, observed with SEM to study the changes of starch granules, lean meat and fat, and their combination.

MATERIALS AND METHODS

1. Sample preparation of starch granules during gelatinization: 1 gram of starch(from potato or corn) was taken, mixed with 10ml distilled water and then heated and kept for 5min. separately at 50°C, 62°C, 64°C, 70°C, 80°C. A group of specimens were taken at each temperature, fixed in 6% glutaraldehyde, freeze-fractured, post-fixed in1% osmium tetroxide, dehydrated in series of ethanol, critical point dried, coated with gold and then observed and photographed with a JSM-35CF SEM.

2. Lean meat, fat and starch(from potato or corn)were mixed in proportion of 60:35:5. The mixture was ground while ice water was added. The minced meat was filled into casing, heated and kept at 80°C for 40min. Specimens were taken from different parts of the sausage, fixed in Karnovsky fixative and freeze-fractured. After freeze-fracturing, they were divided into two groups. One group was treated with petroleum ether for fat extraction. The other was left as such. All were then prepared as described previously, observed and photographed with a JSM-35CF SEM.

RESULTS AND DISCUSSION

1. Morphological changes of starch granules(potato starch and corn starch)during heat treatment:

Potato starch granules are found generally round or elliptical in shape, the surfaces of which are relatively smooth. Their size varies from 10μm to 100μm, with an average of 65μm. (Fig.1.) The hillum and concentric rings could be clearly seen under the light microscope. Corn starch granules are generally polyhedral in shape(Fig. 2.). Their size varies very little,being from 5μm to 26μm, the average of which is 15μm. No concentric rings were observed under the light microscope.

When potato starch was heated to 50°C in water, a longitudinal thin tube appeared at the centre of some granules, even though no exterior changes could be observed at this time. In the tube a sponge-like structure could be clearly seen(Fig.3.). As the heating temperature rose, the diameter of the tube gradually became bigger while the granules swelled. When the heating temperature rose to 62°C, closely distribrted pores and irregular hollows appeared on the surfaces of the granules(Fig.4.). Almost all of the interior structure appeared spongy(Fig.5.). These pores gradually expanded with the rising of the heating temperature. At 70°C, some of the expanded pores united into bigger ones. In addition, more irregular hollows appeared while folds could be clearly seen(Fig.6.). The modified granules now formed a sponge-like mass. When the heating temperature finally rose to 80°C, the starch granules completely lost their granular shape. The sponge-like mass connected with each other to form a sponge-like body(Fig. 7.).

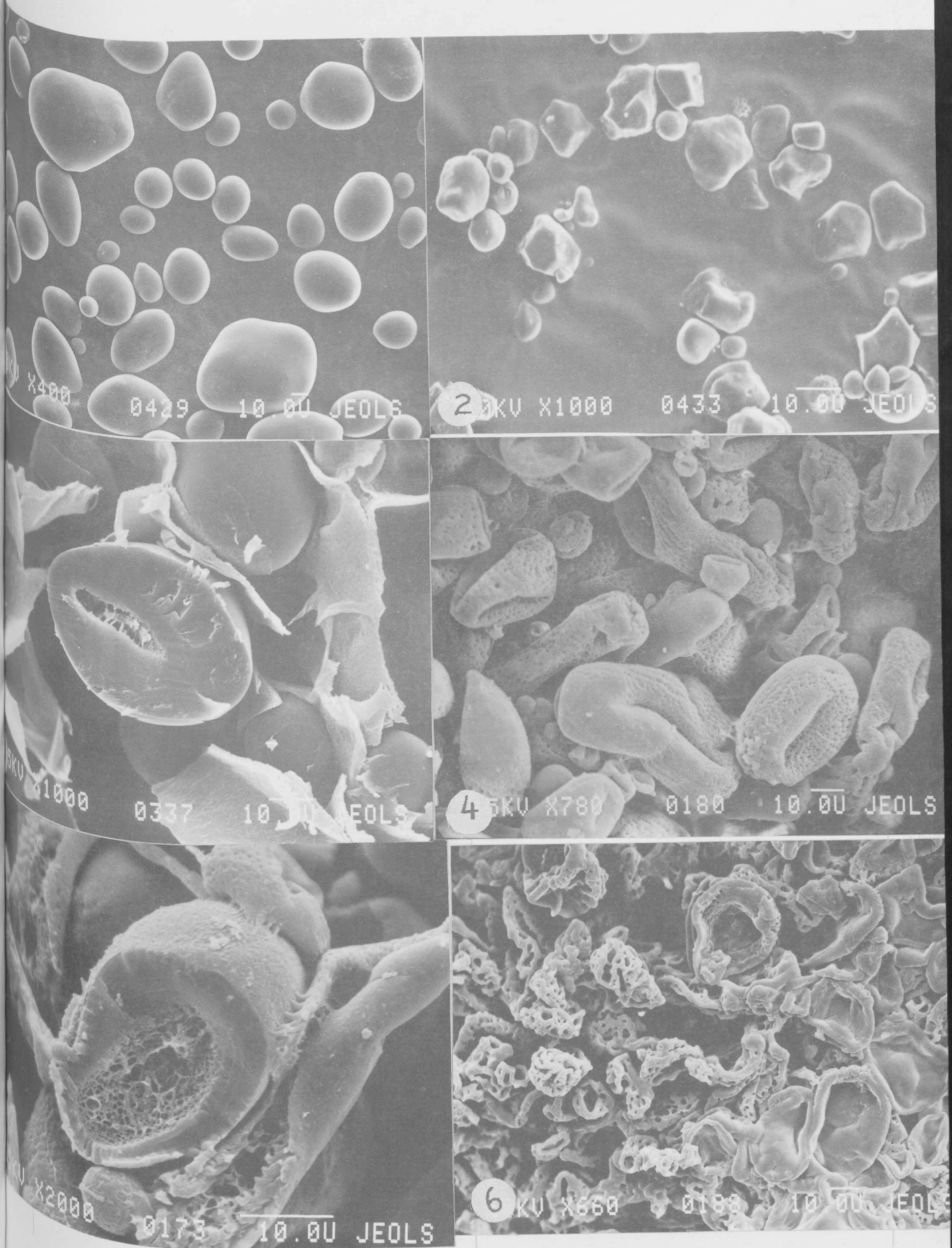
When corn starch was heated to 50°C in water, the appearance of the granules changed much, wheras only a small hole appeared at the centre

(Fig.8.). As the heating temperature rose to 64°C, the granules were full of sponge-like structure, their volume expanded greatly and irregular hollows appeared on the surfaces(Fig. 9.). At 70°C, the granules swelled further, forming more sponge-like structures(Fig.10.). When the heating temperature finally rose to 80°C, the characteristics of their appearance disappeared. These modified granules united together and formed a sponge-like mass(Fig.11.).

When sausage was added with corn starch and observed with scanning electron microscope, the starch granules appeared much swelled and micro holes could be seen on their surfaces(Fig. 14.). These suggested that the interior sponge-like structure had been formed. In addition, protein could be seen sticking to the granules(Fig.16.) Fig.15 showed that starch granules were tightly wrapped up by fat and protein. Some of the muscular protein after being heated, coagulated to form granules and filaments, while others formed sponge-like structure further(Fig.14,18,20). Some of the muscular tissue could still be seen (Fig.14,16,17,18), wheras the structure was different from the uncooked ones(Fig.12). It was supposed that the appearance of large pieces of muscular tissue was attributed to the incompletely grinding.

Scanning electron micrographs of potato starch sausage and corn starch sausage revealed similar structures. The microhraph of freeze-fractured face of a potato starch granule in the sausage revealed the interior sponge-like structure(Fig.20). However the changes of its appearance were much less compared with those in Fig.7. What is the reason for the different appearance of the same type of starch granules at the same heating temperature? This is probably attributed to the different quantity of water arround the granules. When starch granules were heated in water they could absorb as much water as possible and swell well showing great structural changes. However within the sausage they could not absorb water as much as they can, Because of the limited of water content.

Fig.15 and Fig.19 revealed fat in starch sausage from which it could be clearly demonstrated that fat existed as massed. Their hight and size were different. Muscular tissue, protein and starch granules existed among these fat masses. Combined to each other, they form a uniform body.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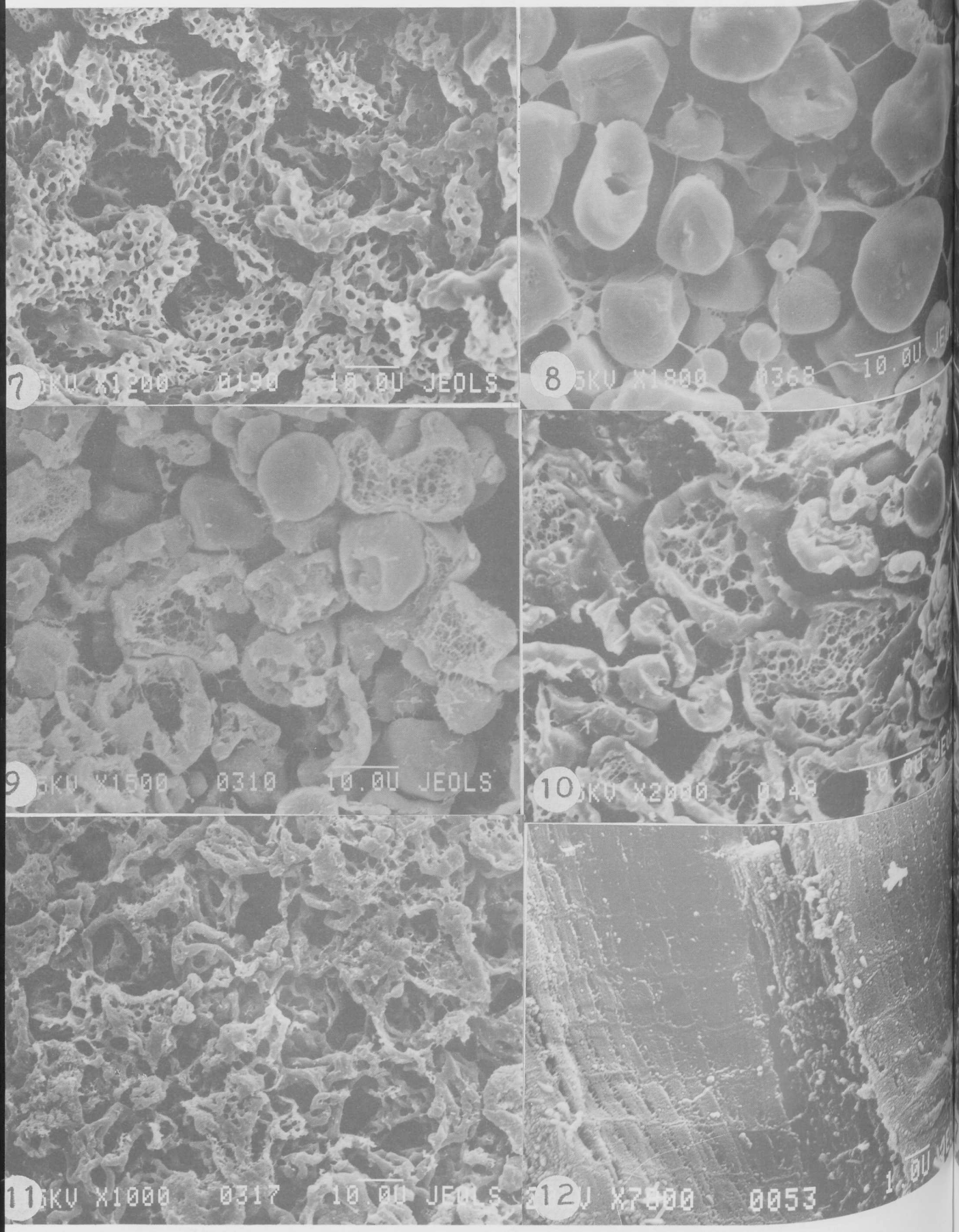
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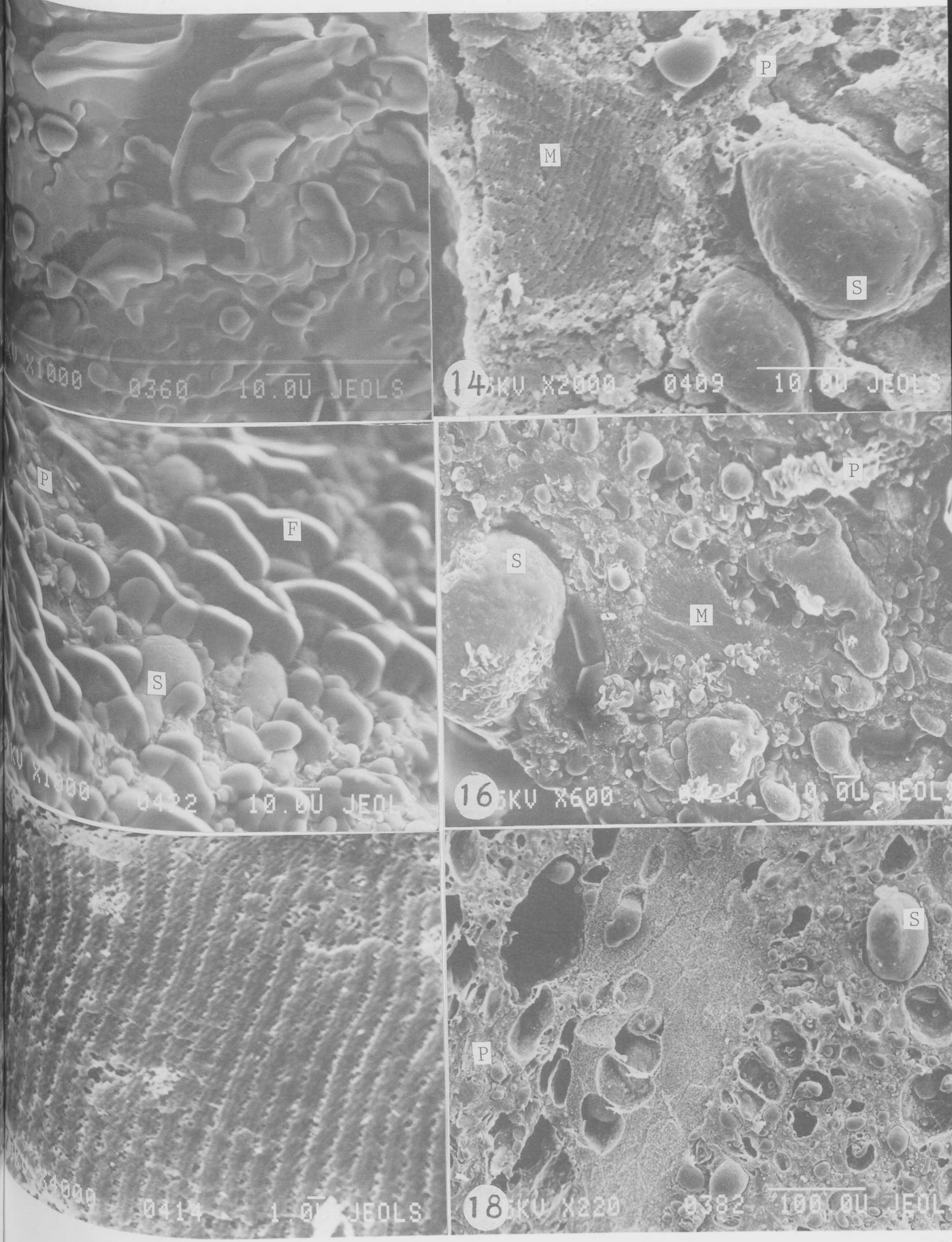
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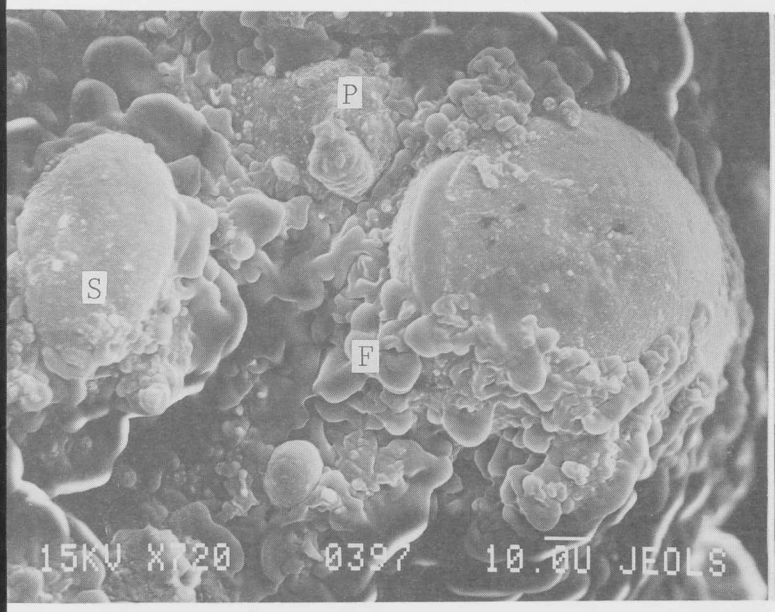
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Legend of figure:
Fig 1: unmodified potato starch granule; Fig 2: unmodified corn starch granules Fig 3: a potato starch granule heated to 50°C, showing the interior tube-like structure; Fig 4: potato starch granules heated to 62°C, showing exterior changes; Fig 5: a potato starch granule heated to 62°C, showing interior changes; Fig 6: potato starch granules heated to 70°C, showing exterior chages; Fig 7: potato starch granules heated to 80°C, showing exterior changes; Fig 8: corn starch granules heated to 50°C, showing exterior and interior changes; Fig 9: corn starch granules heated 64°C, showing exterior and interior changes; Fig 10: corn starch granules heated to 70°C, showing exterior and interior changes; Fig 11: corn starch granules heated to 80°C, showing exterior and interior changes. Fig 12: fresh lean pork; Fig 13: uncooked fat; Fig 14: sausage with 5% corn starch: M: muscle; S: starch; P: protein; Fig 15: sausage with 5% corn starch; F: fat; S: starch; P: protein; Fig 16: sausage with 5% corn starch(fat extracted); S: starch; P: protein; Fig 17: the muscle tissue in sausage with 5% corn starch(fat extracted); Fig 18: sausage with 5% potato starch(fat extracted); S: starch; M: muscle; P: protein; Fig 19: sausage with 5% potato starch; S: starch; F: fat; P: protein; Fig 20: sausage with 5% potato starch; S: starch; P: protein.