

HISTOCHEMISTRY OF THE EPITHELIUM OF THE GASTRIC MUCOSA IN A SERIES OF MAMMALS

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The carbohydrate-containing biopolymers in the epithelium of the gastric mucosa of a series of mammals (cats, pigs, rabbits, guinea-pigs, rats) were studied by histochemical methods in an attempt to obtain a model with histochemical properties close to those of the human gastric mucosa. The model with the closest resemblance was the gastric mucosa of the guinea-pig, for the epithelium of the surface of the stomach and most of the epithelium lining the ducts contain only PAS-positive polysaccharides, while the epithelium of the base of individual ducts also contains sulfonated glycosaminoglycans.

In their histochemical properties (content of carbohydrate-containing biopolymers) the human gastric mucosa and the gastric mucosa of the dog differ considerably [1, 3, 8, 9, 16]. However, the dog's stomach is the chief experimental model used to study the functional and histochemical properties of the gastric mucosa under experimental conditions and the results obtained are usually compared with the mechanism of development of disease in man. Too little attention has been paid to the study of the gastric mucosa of other laboratory animals [17].

The object of the present investigation was to make a combined histochemical study of carbohydrate-containing biopolymers in the epithelium of the gastric mucosa of a series of mammals from the comparative histochemical aspect in order to obtain a model which would correspond in its histochemical properties to the human gastric mucosa.

EXPERIMENTAL METHOD

Preparations of the gastric mucosa of pigs, cats, rabbits, rats, and guinea-pigs were fixed in Hamperl's and Carnoy's fluids and in 10% neutral formalin solution. The material was embedded in paraffin wax in the usual way. Polysaccharides were studied in sections stained by the PAS method [5], with alcian blue at pH 2.7 [11] and at pH 1.0 [10], and with basic brown at pH 1.0 [6]. Control sections were treated with diastase, hyaluronate-lyase [12], and phenylhydrazine [14], and mild acid hydrolysis was used [4, 13]. Carbohydrate-containing biopolymers were identified by the use of the differential schemes of Spicer et al. [15] and Shubich et al. [7].

EXPERIMENTAL RESULTS AND DISCUSSION

The results obtained by the histochemical staining methods are shown in Table 1. The intracellular secretory product of the superficial part of the epithelium and of most of the epithelium lining the duct (the upper two-thirds) in the guinea-pig gave only a diastase-resistant PAS-reaction (Fig. 1), sensitive to phenylhydrazine, because it contained PAS-positive neutral polysaccharide. The intracellular secretory product (ISP) of the epithelium from the base of the single gastric glands stained not only by the PAS method but also with alcian blue at pH 2.7 and also with basic brown (Fig. 2) and alcian blue at pH 1.0. Control treatment did not change the intensity of the alcianophilia (pH 2.7) or the basophilia (pH 1.0) of the ISP of the duct epithelium, possibly because this epithelium contained sulfonated glycosaminoglycans of the chondroitin sulfate B type.

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TABLE 1. Histochemical Characteristics of Carbohydrate-Containing Biopolymers in Epithelium of Gastric Mucosa of a Series of Mammals

Structure	Species of animal	PAS-reaction				Basic brown, pH 1.0		Alcian blue, pH 1.0		Alcian blue, pH 2.7	
		C	D	MAH	P	C	H	C	H	C	MAH
Superficial epithelium	Cat	4	4	4	1-2	0-1	0-1	0	0	1-2	0-1
	Pig	3-4	3-4	3-4	1-2	2	2-3	1-2	1-2	1-3	1-3
	Rabbit	3-4	3-4	3-4	0-1	0	0	0	0	0-1	0
	Guinea-pig	3-4	3-4	3-4	0	0	0	0	0	0	0
	Rat	2-4	2-4	2-4	0-1	0-1	0-1	0-1	0-1	0-1	0-1
Epithelium of duct of gastric glands	Cat	4	3-4	4	1-2	0-1	0-1	0	0	1-2	0-1
	Pig	3-4	3-4	3-4	1-2	1-2	2-3	2	2-3	2-3	2-3
	Rabbit	3-4	3-4	3-4	0-1	0	0	0	0	0-1	0
	Guinea-pig	3-4	3-4	3-4	0	0	0	0	0	0	0
	Rat	3-4	3-4	3-4	0-2	1-3	1-3	1-2	1-2	1-2	1-2
Epithelium of base of duct	Cat	3-4	3-4	3-4	1	0-1	0-1	0	0	1-2	1-0
	Pig	3-4	3-4	3-4	1-2	2	2-3	2-3	2-3	2-3	2-3
	Rabbit	3-4	3-4	3-4	0-1	0-2	0-2	0-2	0-2	0-1	0
	Guinea-pig	1-2	1-2	1-2	0	0-1	0-1	0-1	0-1	0-1	0-1
	Rat	1-2	1-2	1-2	0-2	1-2	1-2	1-2	1-2	2	2

Legend: C) control; D) treatment with diastase; MAH) treatment by mild acid hydrolysis; P) treatment with phenylhydrazine; H) treatment with hyaluronate-liase; 0) absence of staining; 1) weak staining; 2) moderately strong staining; 3) strong staining; 4) very strong staining.

The ISP of the surface layer and of most of the epithelium lining the ducts of the gastric glands in the rabbit's stomach gave a diastase-resistant PAS-reaction and showed alcianophilia at pH 2.7. Weakening of the ISP in the epithelium of the rabbit's gastric mucosa after treatment with phenylhydrazine showed that some of the PAS-positive substance found consisted of neutral polysaccharides. The ability of the epithelium to stain with alcian blue at pH 2.7 and the sensitivity of the alcianophilia to mild acid hydrolysis indicate that the ISP also contained sialic acid. The resistance of the PAS-reaction of the ISP of the rabbit's epithelium to mild acid hydrolysis was probably due to the presence of PAS-negative sialic acid [2]. The ISP of the epithelium at the base of the ducts of a few gastric glands showed not only a PAS-reaction and alcianophilia (pH 2.7), but also basophilia on staining with basic brown and with alcian blue at pH 1.0. The effect of the control treatments on the PAS-reaction and the alcianophilia and basophilia were dependent on the presence of PAS-positive neutral polysaccharides, acid glycoproteins, and sulfonated glycosaminoglycans.

The results of these experiments showed that in the composition of their ISP there is no difference between the gastric epithelium of the cat, pig, and rat, and it includes three types of carbohydrate-containing biopolymers: neutral polysaccharides, acid glycoproteins, and sulfonated glycosaminoglycans. In the surface epithelium and most of the epithelium lining the ducts of the gastric glands in rabbits neutral polysaccharides and acid glycoproteins containing sialic acid were found, while sulfonated glycosaminoglycans also were present in the epithelium of the base of some of the ducts. The ISP of the surface epithelium and most of the epithelium of the ducts in the gastric mucosa of the guinea-pig contained only neutral PAS-positive polysaccharides, while the epithelium of the base of some of the ducts also contained sulfonated glycosaminoglycans. In its histochemical properties the ISP of the surface epithelium and of most of the epithelium lining the ducts of the gastric glands of the guinea-pig correspond to the ISP of the epithelium of the human gastric mucosa [9]. Differences were found in the composition of the ISP of the epithelium lining the base of the ducts where, besides neutral polysaccharides, sulfonated glycosaminoglycans were present in a few ducts of the guinea-pig, while in man, according to Lev [9], acid glycoproteins with sialic acid are present.

In the histochemical characteristics of the secretions which it produces, the gastric epithelium of the guinea-pig thus bears the closest resemblance to the epithelium of the human stomach. The

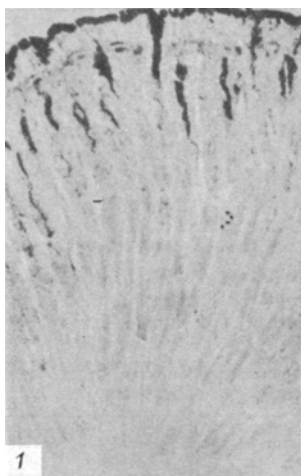


Fig. 1

Fig. 1. Strong PAS-reaction of surface and duct epithelium in gastric mucosa of a guinea-pig (70×).

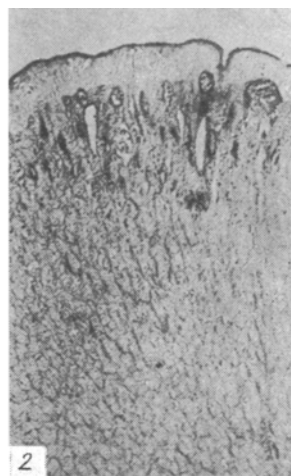


Fig. 2

Fig. 2. Staining of extracellular secretory product and epithelium of base of single ducts of glands in gastric mucosa of guinea-pig with basic brown at pH 1.0 (70×).

guinea-pig ought therefore to be used for experiments to study the histochemical dynamics of the epithelium of the gastric mucosa.

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