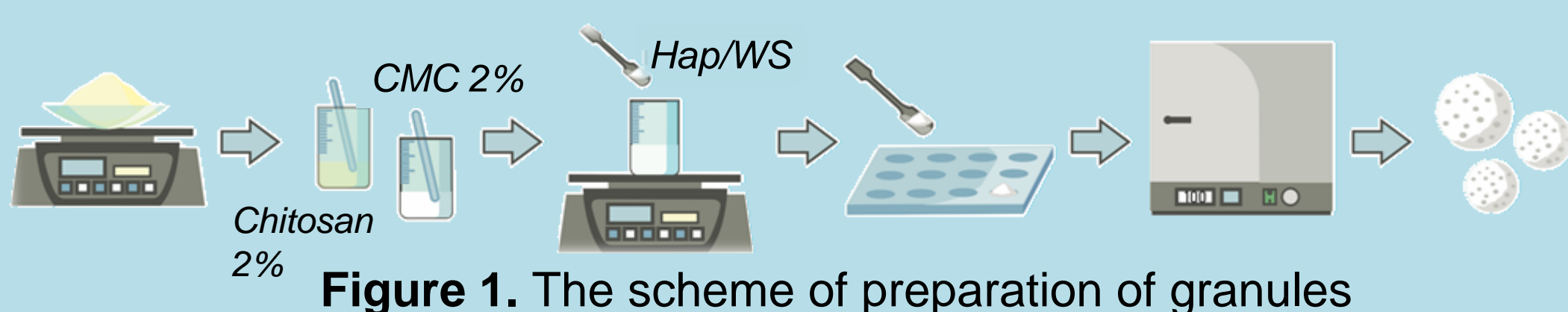




## INTRODUCTION

Composite materials are used in medicine for a wide range of practical tasks to improve human health. In traumatology and orthopedics, materials are used that combine biodegradable polymers with inorganic salts, most often calcium phosphates. Currently, the selection of multicomponent compositions of inorganic fillers that perform different functions and improve the characteristics of transplants is considered promising. In particular, the combination of phosphates and calcium silicates is of interest.

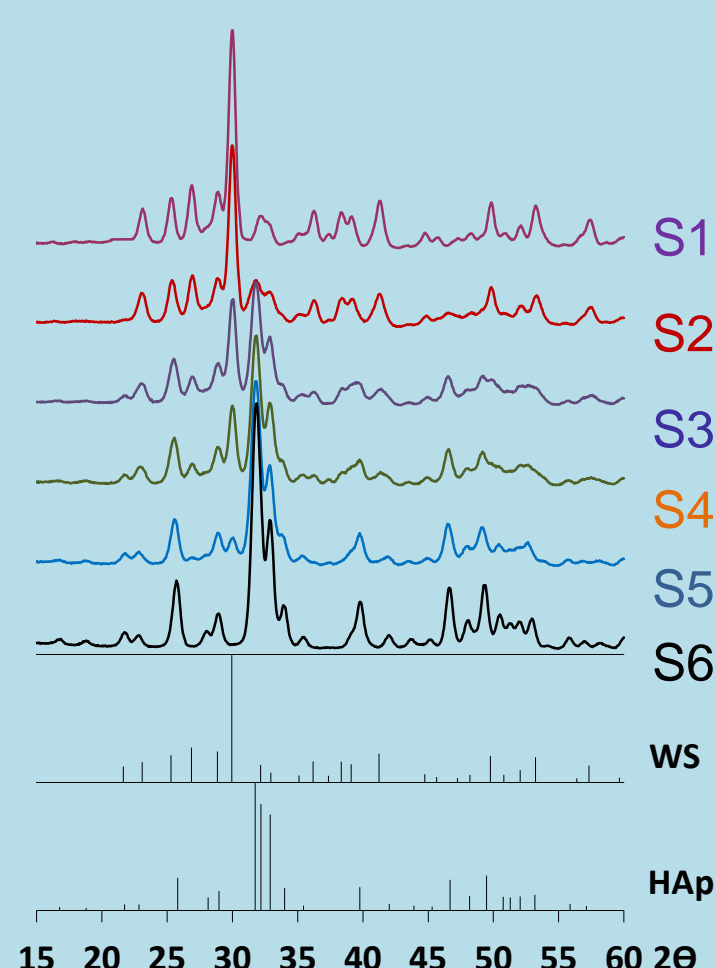
## MATERIALS & METODS



**Figure 1.** The scheme of preparation of granules

**Table 1.** Granule manufacturing materials

Name	HAp/WS, mas. %	D <sub>median</sub> , μm	Paste concentration (g powder/ml hydrogel CS/CMC)
S1	0 / 100	133.3	0.6
S2	20 / 80	133.8	1.5
S3	40 / 60	110.7	0.5
S4	60 / 40	99.0	0.65
S5	80 / 20	87.7	0.5
S6	100 / 0	94.3	1.5



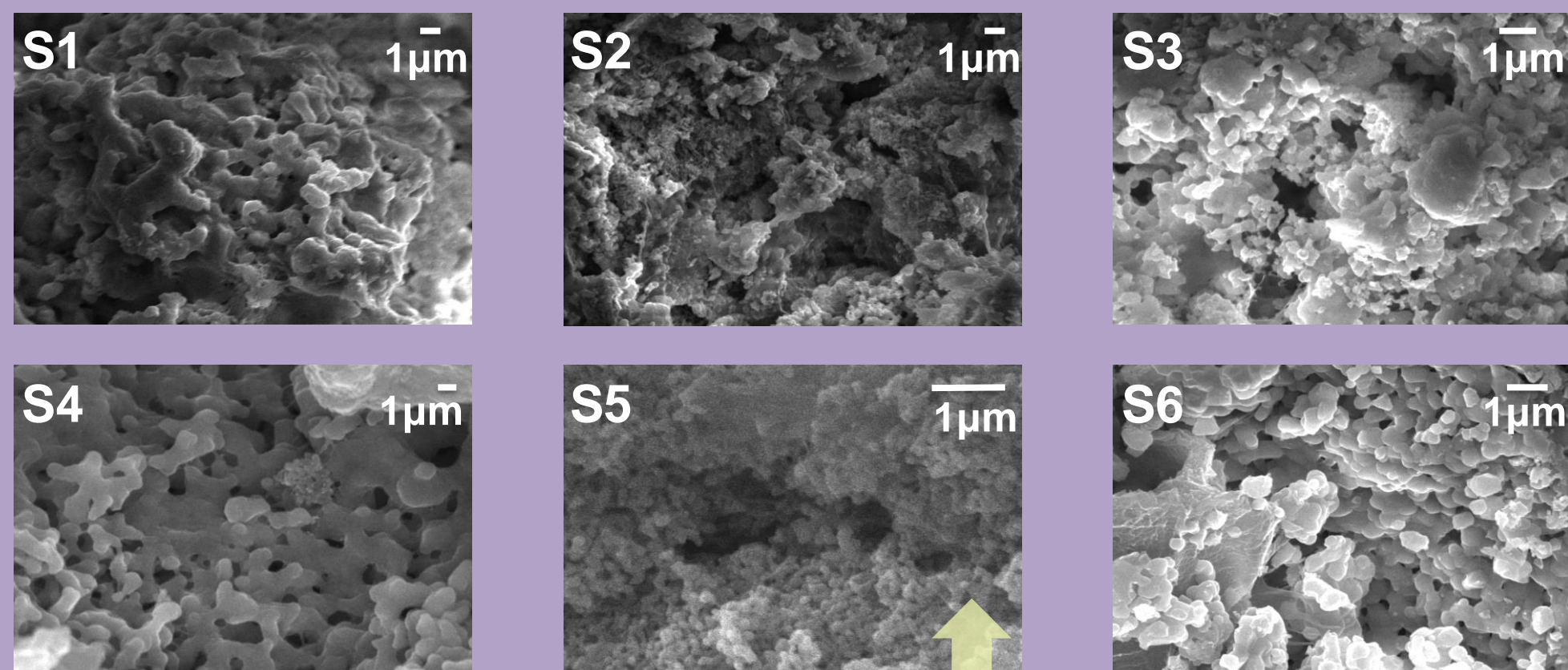
**Figure 2.** XRD Initial powders



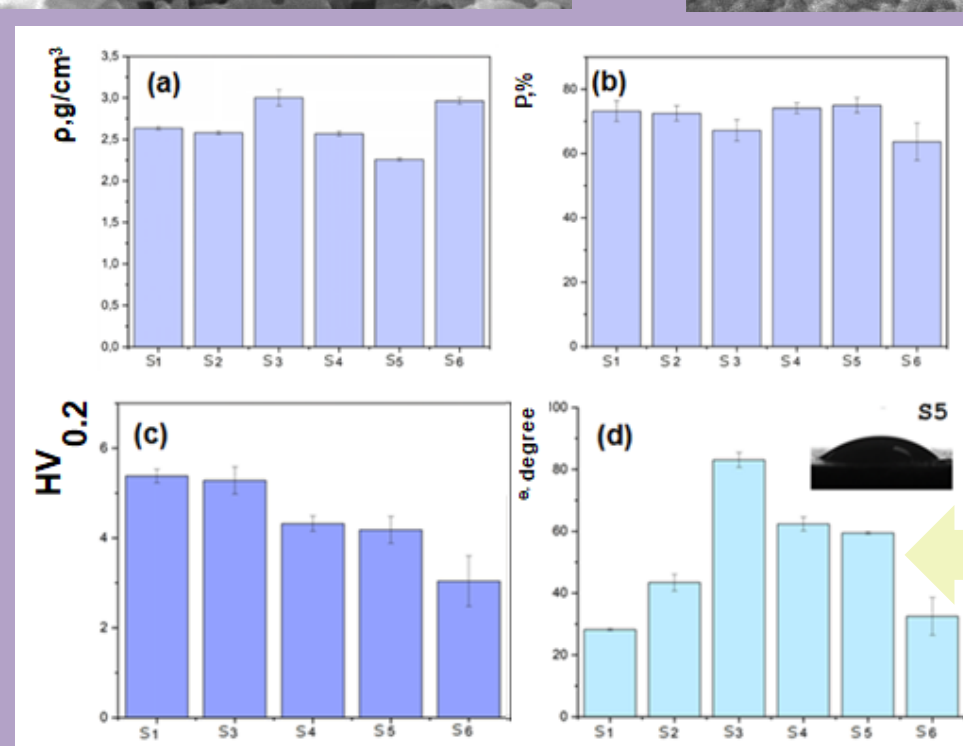
**Figure 3.** The shape of the granules:  
a – spheres, b – cylinders, c - hemispheres

## RESULTS & DISCUSSION

### 1. Morphology and physical properties



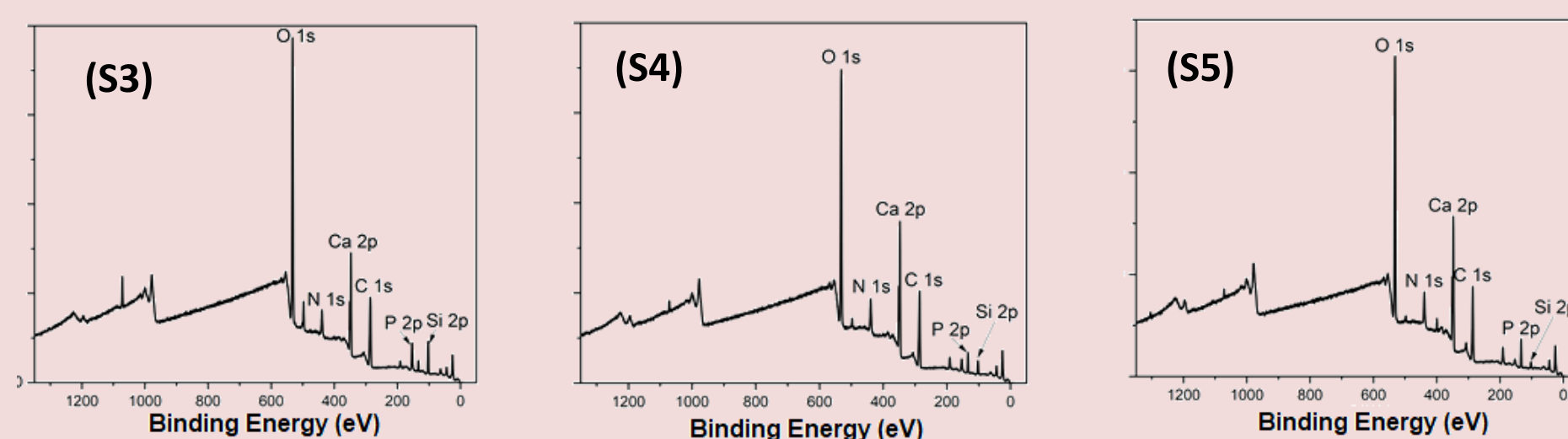
**Figure 4.** SEM images of the surface of granules S1-S6



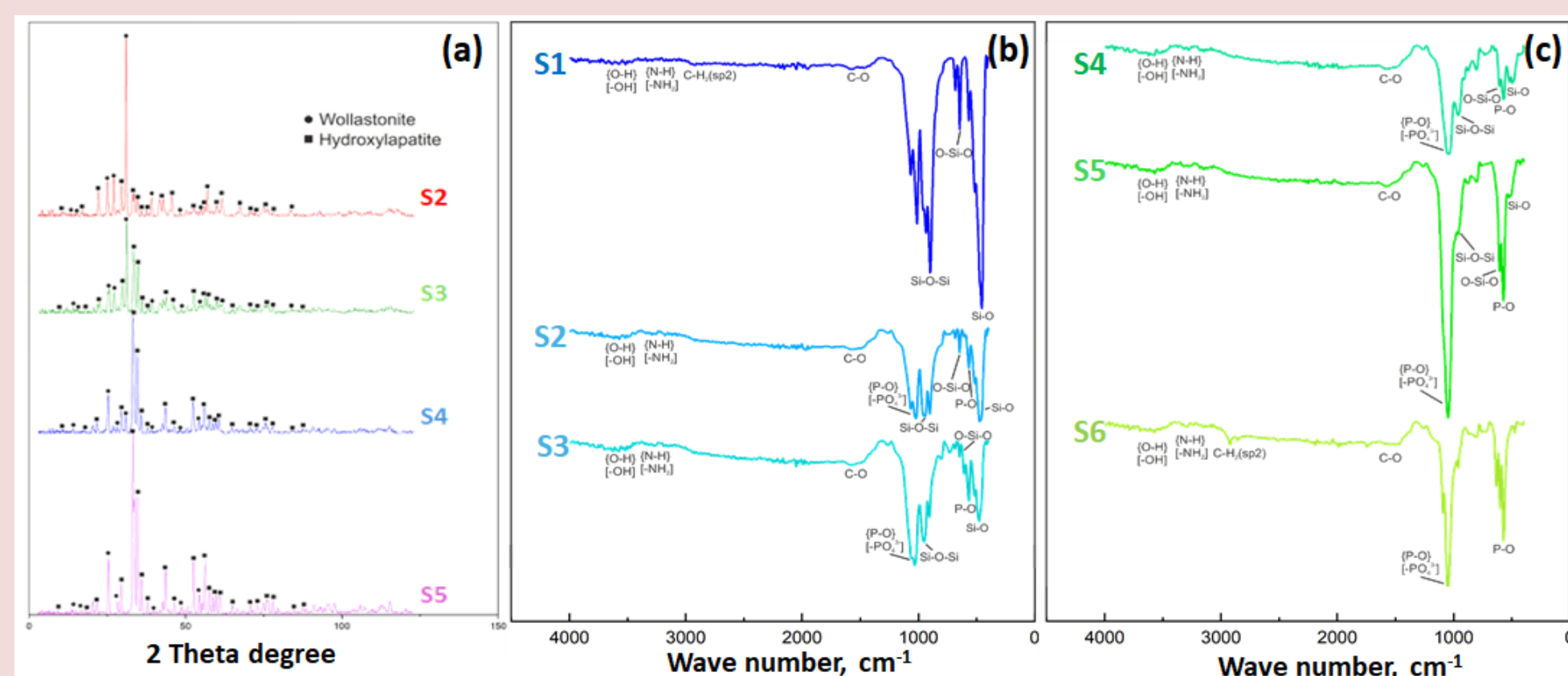
**Figure 5.** Physico-chemical properties of granules:  
a – density, b – porosity, c – microhardness, d – contact angle

## RESULTS & DISCUSSION

### 2. Chemical characterization



**Figure 6.** XPS spectra of granules S3-S5

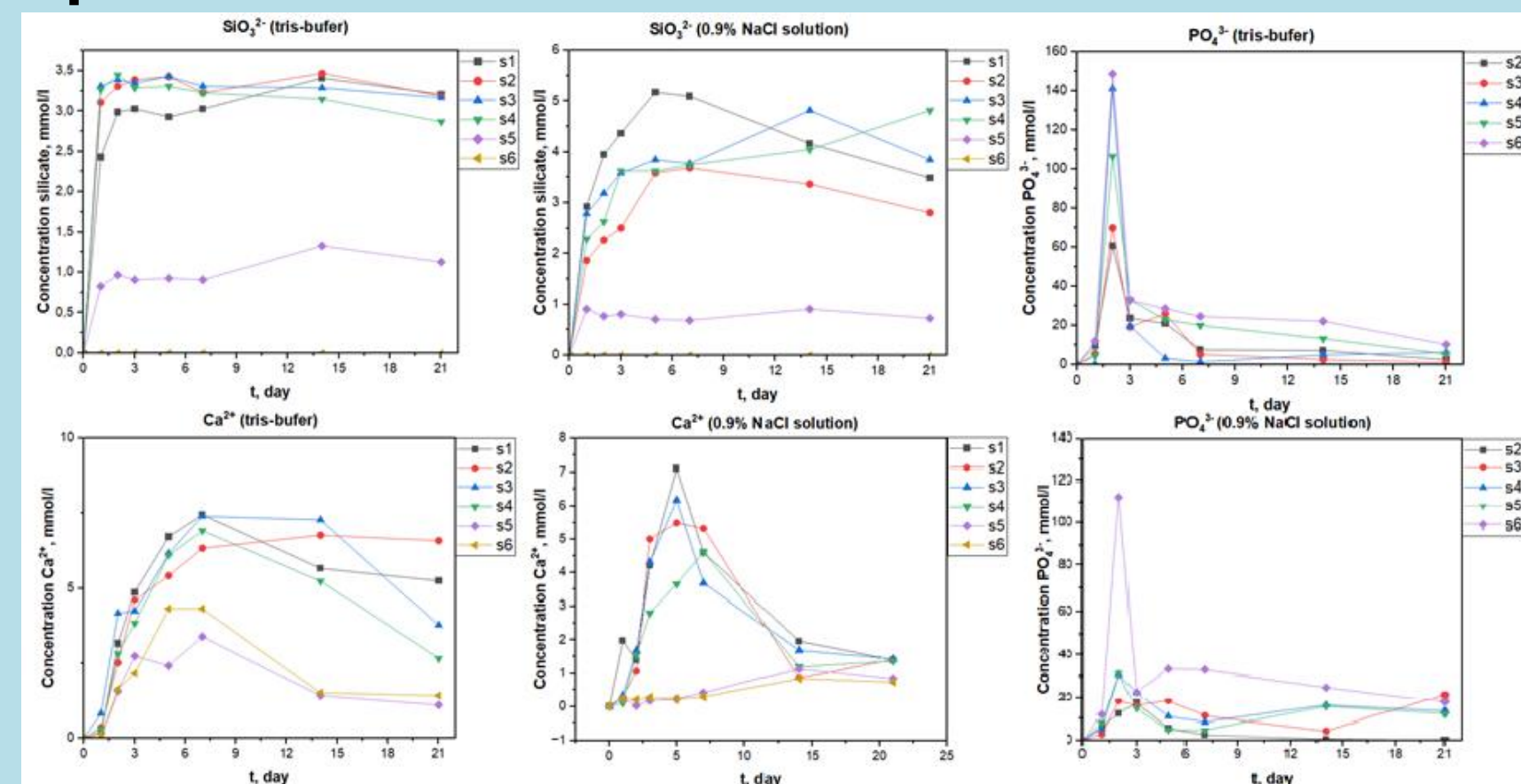


**Figure 7.** XRD (a), FTIR spectra (b, c) of composite granules

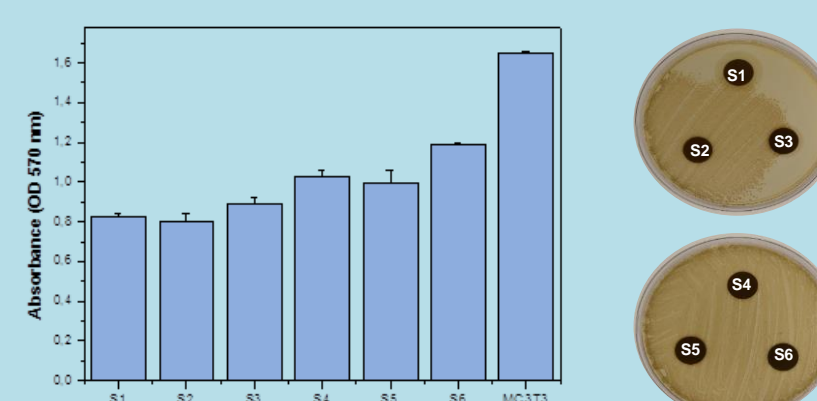
**Table 2.** Characteristic peaks by the XPS analysis of Hip/WS/CS/CMC granules and the atomic composition of the surface

The peak of the element	Binding energy (eV)	Chemical bonds	Atomic composition, at. %		
			S3	S4	S5
O 1s	530.1	O–P			
	530.9-531.1	O=P	42.83	41.89	43.92
	532.4-532.6	C–O, Si–O			
Ca 2p	346.5	Ca 2p3/2	8.23	10.21	10.69
	350	Ca 2p1/2			
P 2p	132.8	P–O	2.33	5.13	6.96
Si 2p	101.7-101.8	Si–O–C	11.55	5.47	3.04
	103	Si–O–Si			
C 1s	284.6	C–H, C–C			
	286.2	C–O–C	34.67	37.30	33.45
	287.6-288	O=C–O			
N 1s	399.1	C–N	0.38	–	1.93
	400.7-402	C–NH			

### 3. In vitro degradation. MTT-test and antibacterial properties



**Figure 8.** Degradation of granules in tris-buffer and 0.9% NaCl solution



**Figure 9.** MTT-Test (MC3T3) and antibacterial activity against *Staphylococcus aureus* (MW2)

**CONCLUSIONS:** Based on the results obtained, the new materials obtained are suitable for bone regeneration and can be studied in vivo/.