RESEARCH ARTICLE

Insect-based chitin and chitosan from whole body sources and rearing by-products: extraction, physicochemical, structural and bioactivity characterisation

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Supplementary material

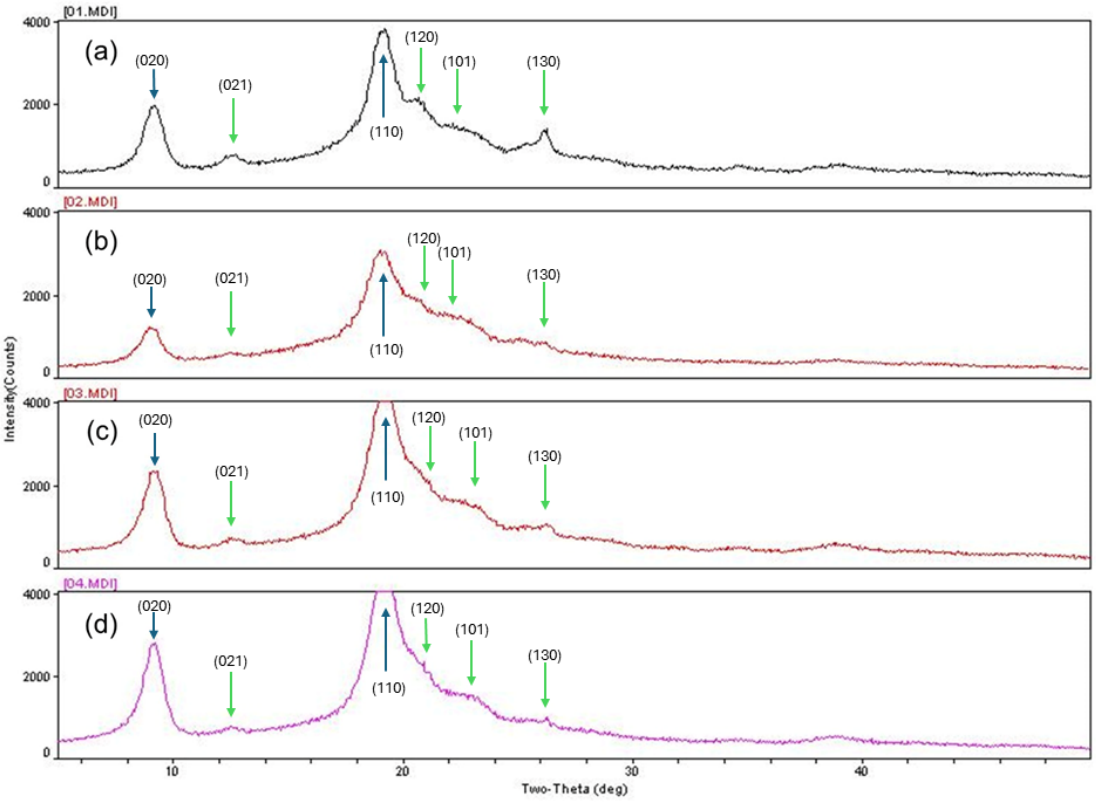

FIGURE S1 XRD patterns of chitin from various sources: (a) commercial chitin, (b) *T. molitor* larvae (TM), (c) *A. domesticus* (AD) and (d) *A. domesticus* legs & wings (house cricket L&W); Blue arrows indicate major peaks on the plane and green arrows indicate minor peaks on the plane.

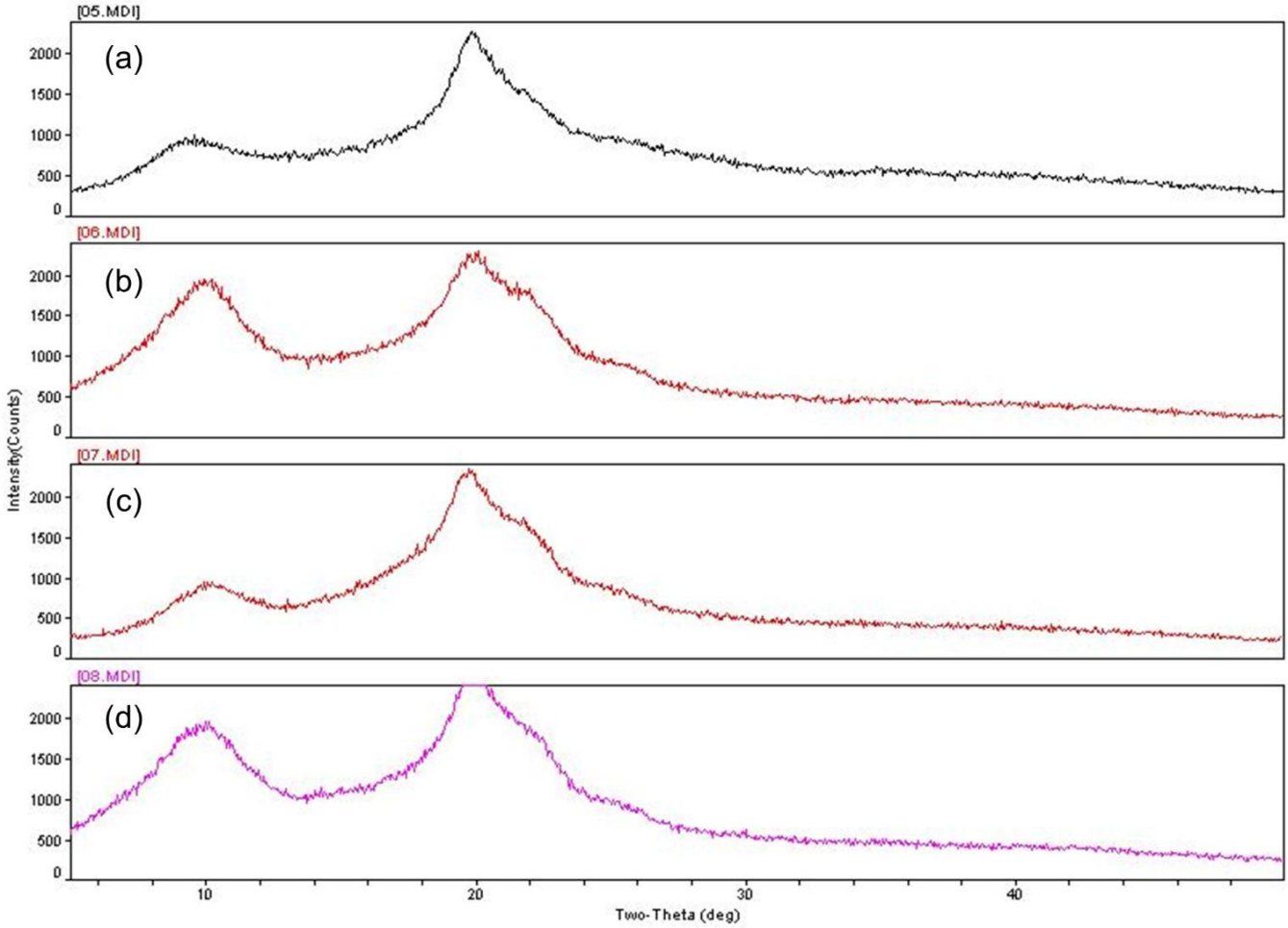

FIGURE S2 XRD patterns of chitosan from various sources: (a) commercial chitin, (b) *T. molitor* larvae (TM), (c) *A. domesticus* (AD) and (d) *A. domesticus* legs & wings (house cricket L&W).

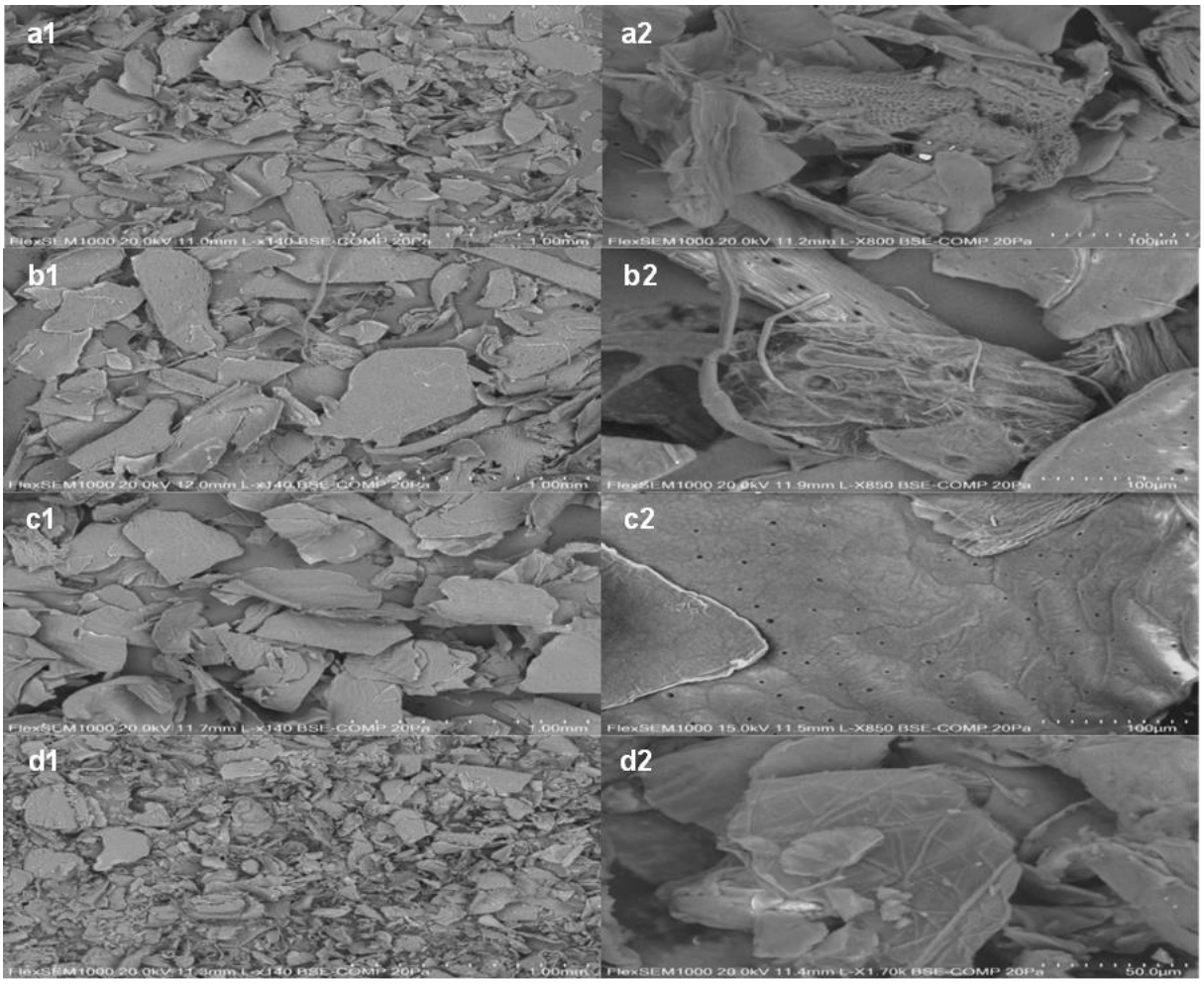

FIGURE S3 Surface morphology of chitin samples (a) *A. domesticus* (AD), (b) *A. domesticus* legs & wings (house cricket L&W), (c) *T. molitor* larvae (TM), (d) commercial chitin from SEM images at different magnifications (1 = x170; 2 = x1.7k).

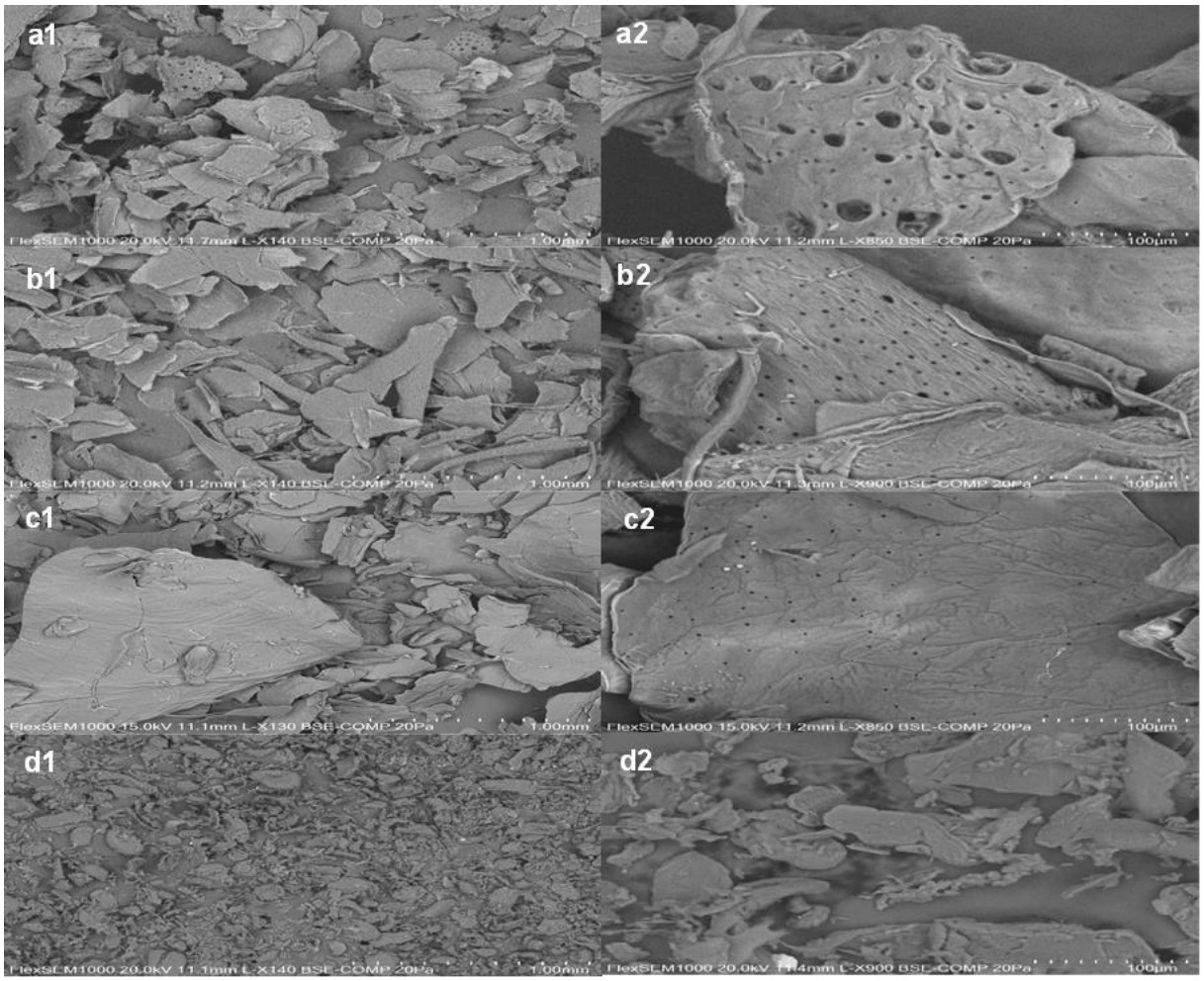

FIGURE S4 Surface morphology of chitosan (a) *A. domesticus* (AD), (b) *A. domesticus* legs & wings (house cricket L&W), (c) *T. molitor* larvae (TM), (d) – commercial chitin from SEM images at different magnifications (1 = x170; 2 = x1.7k).

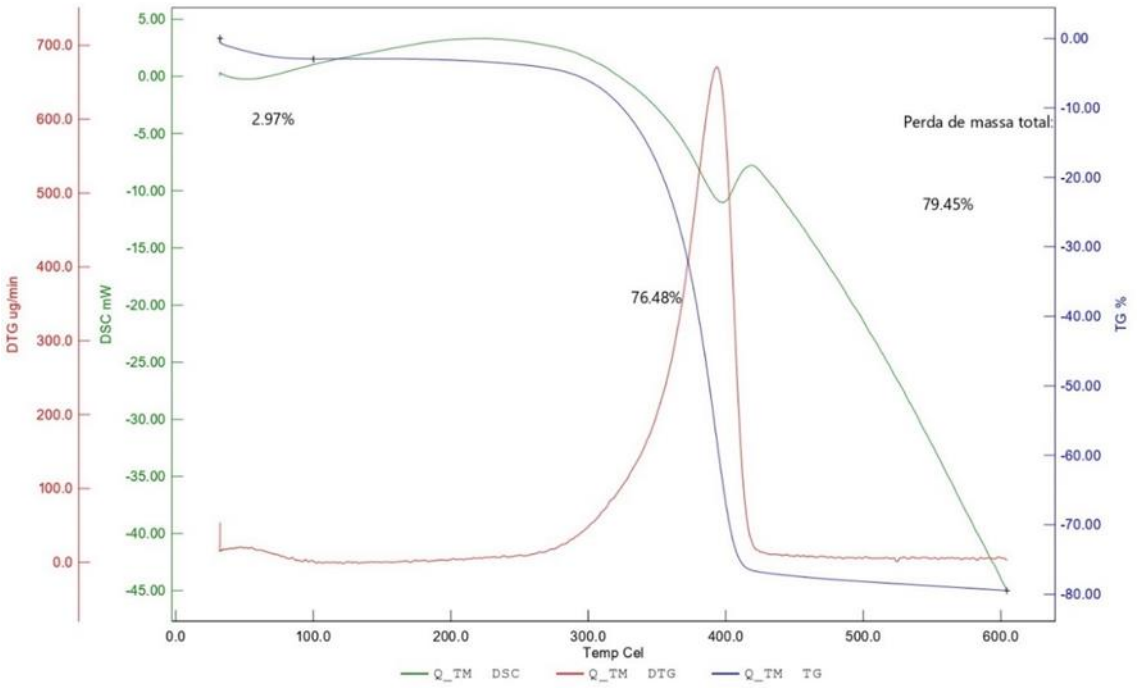

FIGURE S5 DTG, TG and DSC curves of *T. molitor* larvae (TM) chitin.

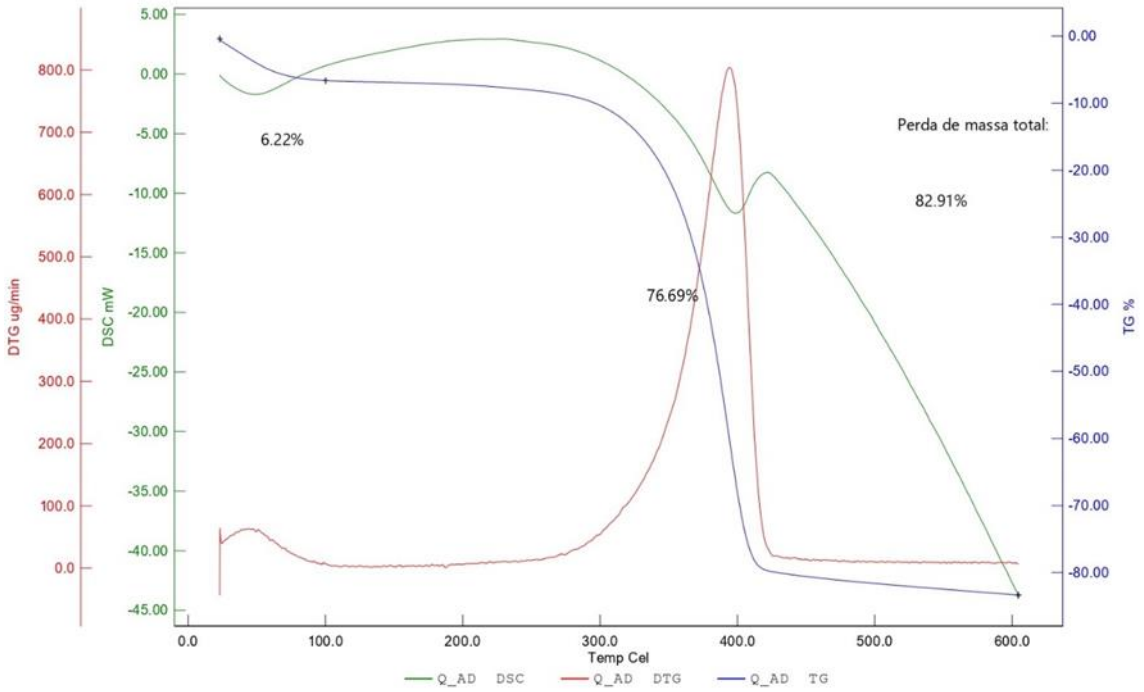

FIGURE S6 DTG, TG and DSC curves of *A. domesticus* (AD) chitin.

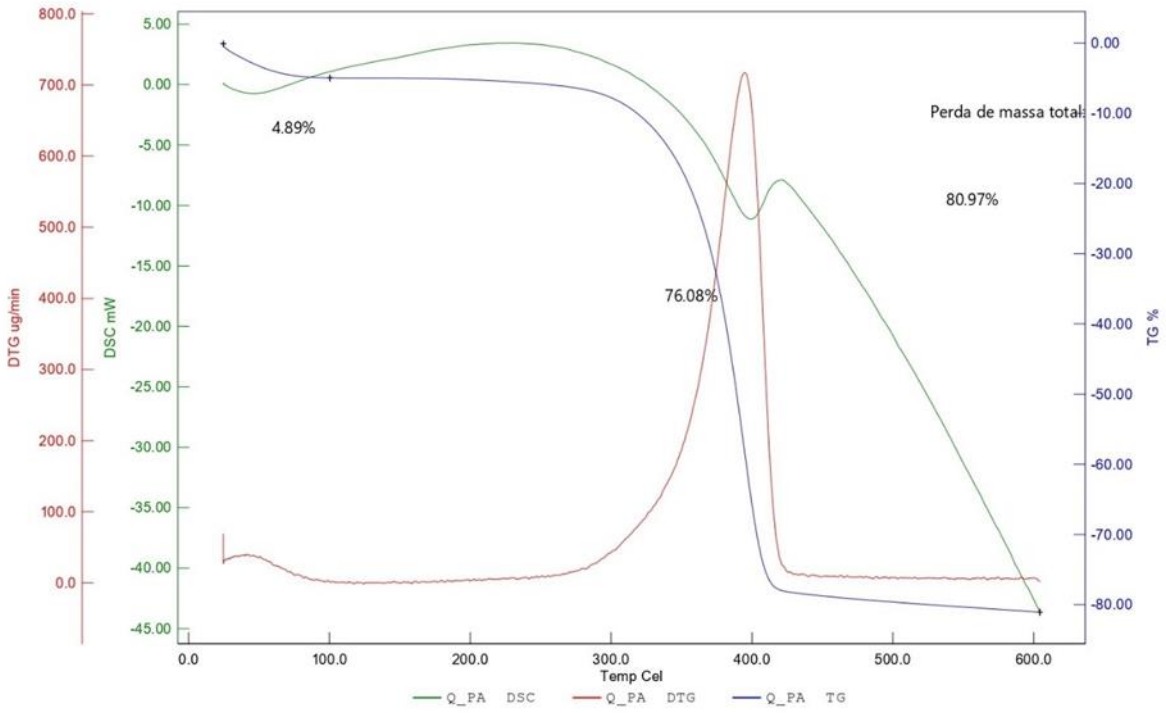

FIGURE S7 DTG, TG and DSC curves of *A. domesticus* legs & wings (house cricket L&W) chitin.

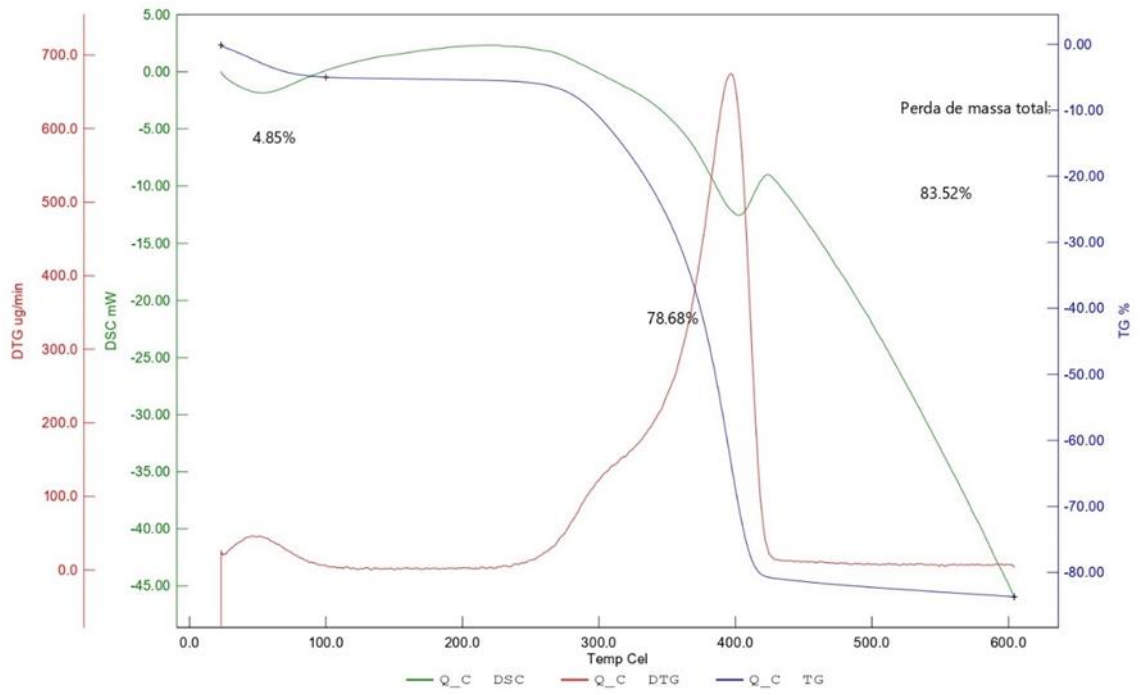

FIGURE S8 DTG, TG and DSC curves of commercial chitin.

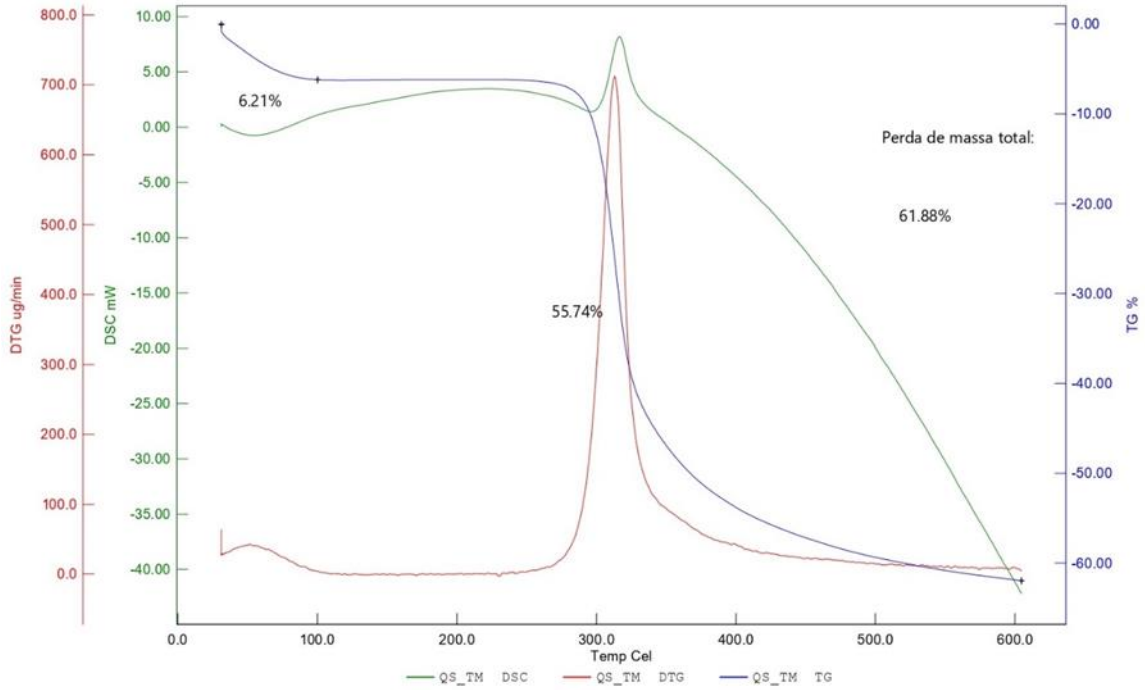

FIGURE S9 DTG, TG and DSC curves of *T. molitor* larvae (TM) chitosan.

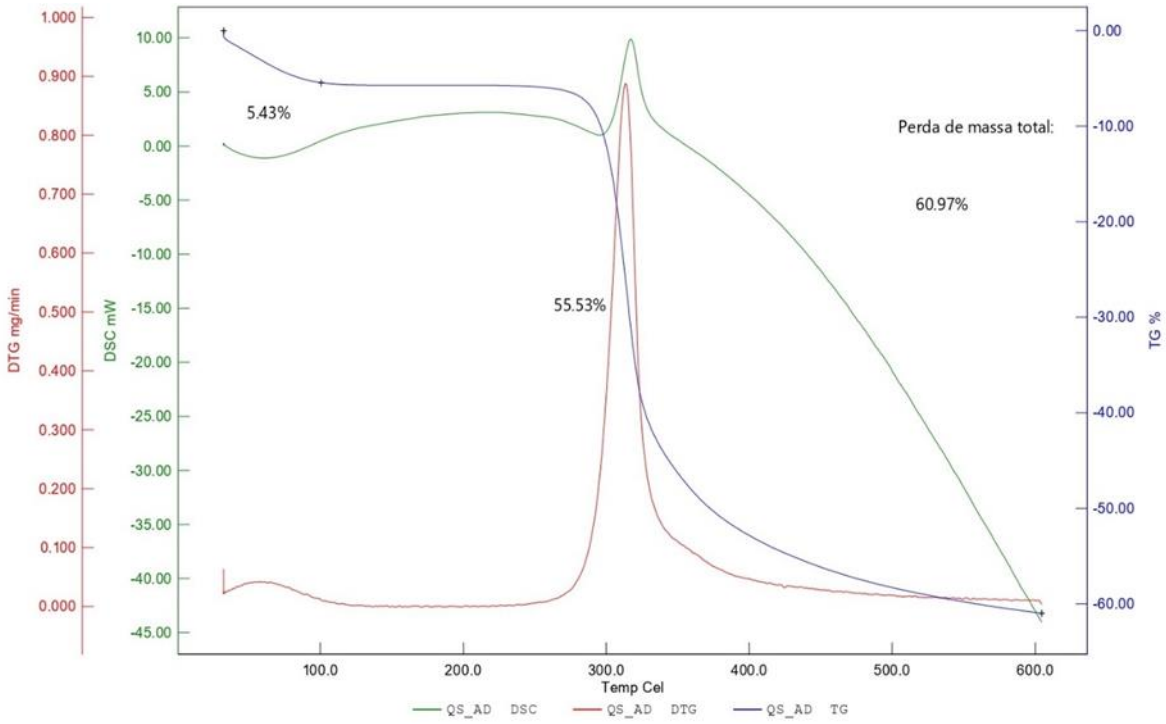

FIGURE S10 DTG, TG and DSC curves of *A. domesticus* (AD) chitosan.

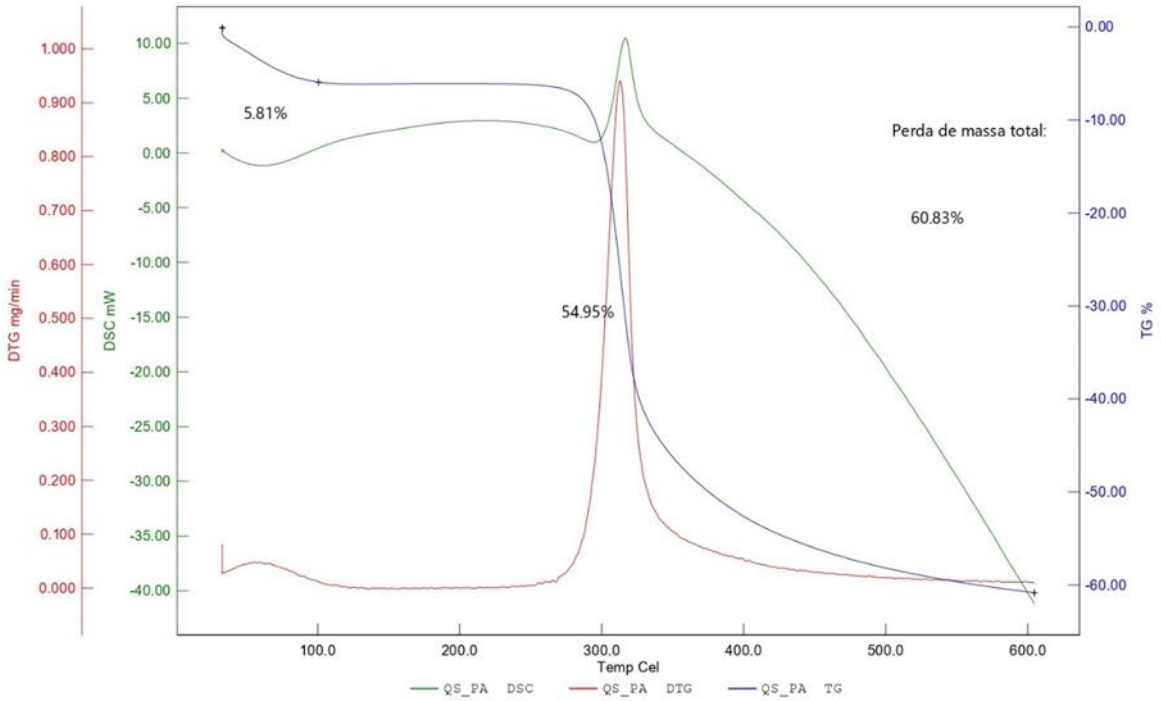

FIGURE S11 DTG, TG and DSC curves of *A. domesticus* legs & wings (house cricket L&W) chitosan.

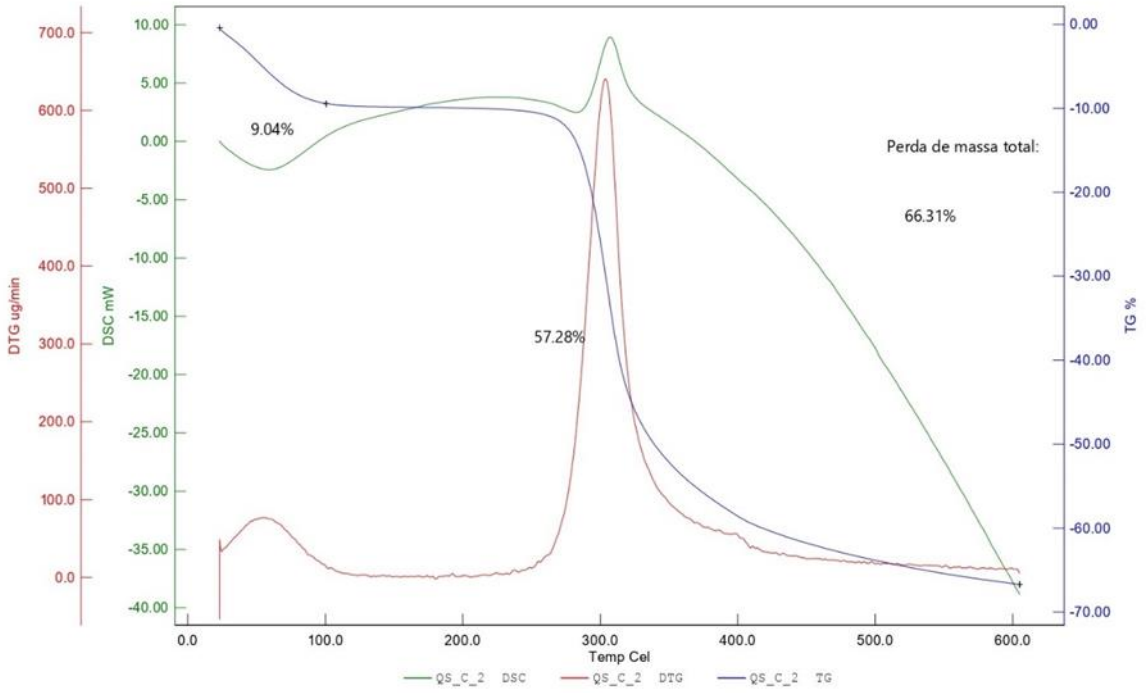

FIGURE S12 DTG, TG and DSC curves of commercial chitosan.

TABLE S1 Color (CIE-Lab*)coordinates and whiteness index (n = 6, mean ± SD) of chitosan samples

Samples	Chitosan			
	*L**	*a**	*b**	WI
T. molitor larvae (TM)	77.61 ± 1.19[b]	2.93 ± 0.07[b]	13.95 ± 0.10[d]	73.45 ± 1.04[b]
A. domesticus (AD)	71.20 ± 0.17[d]	3.50 ± 0.8[a]	15.43 ± 0.15[c]	67.13 ± 0.20[d]
A. domesticus by-products (house cricket L&W)	75.03 ± 0.24[c]	3.13 ± 0.15[b]	16.64 ± 0.65[b]	69.83 ± 0.24[c]
Commercial	101.07 ± 2.37[a]	1.87 ± 0.21[c]	17.22 ± 0.22[a]	82.51 ± 0.24[a]

[a, b, c, d]Homogenous groups in each column according to Tukey's *post hoc* test ($P < 0.05$).

TABLE S2 Wavenumber of the different peaks attributed to functional groups characteristics of chitin

Functional group and vibration modes	Classification	*T. molitor* larvae (TM)	*A. domesticus* (AD)	*A. domesticus* by-products (L&W)	Commercial
O-H stretching	–	3,437	3,436	3,443	3,359
N-H stretching	–	3,097; 3,254	3,092; 3,255	3,097; 3,253	3,087; 3,254
CH_3 symmetric stretch and CH_2 asymmetric stretch	Aliphatic compounds	2,930	2,957	2,926	2,956
CH_3 symmetric stretch	Aliphatic compound	2,875	2,882	2,871	2,879
C=O secondary amide stretch	Amide I	1,651	1,651	1,652	1,652
C=O secondary amide stretch	Amide I	1,620	1,620	1,620	1,622
N-H bend, C-N stretch	Amide II	1,550	1,550	1,550	1,551
CH_2 ending and CH_3 deformation	–	1,422	1,422	1,424	1,421
CH bend, CH_3 symmetric deformation	–	1,372	1,373	1,372	1,373

CH_2 wagging	Amide III, components of protein	1,306	1,307	1,305	1,308
Asymmetric bridge oxygen stretching		1,154	1,153	1,155	1,153
Asymmetric in-phase ring stretching mode	Saccharide rings	1,114	1,112	1,115	1,111
C-O-C asymmetric stretch in phase ring		1,067	1,066	1,067	1,066
C-O asymmetric stretch in phase ring	–	1,008	1,012	1,006	1,013
CH_3 wagging	Along chain	949	950	949	950
CH ring stretching	Saccharide rings	894	895	894	894

TABLE S3 Lipid peroxidation inhibition (%, mean ± SD) for chitosan samples and control (BHT) according to β-carotene bleaching test

Samples	Lipid peroxidation inhibition (%)					
	50 mg/L	100 mg/L	250 mg/L	500 mg/L	750 mg/L	1000 mg/L
T. molitor larvae (TM)	2.5 ± 1.2^{b}	14.5 ± 0.3^{b}	29.4 ± 0.5^{c}	36.3 ± 0.8^{b}	36.3 ± 0.8^{b}	42.1 ± 0.3^{c}
A. domesticus (AD)	4.5 ± 2.8^{b}	17.9 ± 0.9^{b}	34.4 ± 1.8^{b}	43.2 ± 1.8^{ab}	50.3 ± 0.6^{b}	54.5 ± 0.9^{ab}
A. domesticus by-products (L&W)	2.8 ± 1.7^{b}	16.9 ± 2.7^{b}	31.0 ± 1.4^{bc}	33.1 ± 1.4^{b}	39.5 ± 1.4^{a}	46.1 ± 5.5^{bc}
Commercial	15.5 ± 1.4^{a}	26.4 ± 0.4^{a}	44.9 ± 0.2^{a}	52.8 ± 0.4^{a}	55.2 ± 1.9^{a}	62.4 ± 0.1^{a}
BHT	43.4 ± 0.6	53.8 ± 0.7	71.1 ± 0.8	82.1 ± 1.1	90.3 ± 1.6	93.4 ± 3.8

$^{a, b, c}$Homogenous groups in each column according to Tukey's *post hoc* test ($P < 0.05$).