

Table 1 Viscosity and keratin yield from various extraction systems

Extraction systems	Specific viscosity of supernate	Yield
8M urea	2.52	68.64±2.52%
4M urea	2.14	58.40±3.42%
10% SDS	1.46	31.20±2.51%
2M urea 5%SDS based on feather	1.72	48.50±2.43%
2M urea 8%SDS based on feather	2.01	61.80±3.56%
2M urea 10%SDS based on feather	2.52	66.90±3.14%
2M urea 15%SDS based on feather	2.73	67.14±2.97%
2M urea 20%SDS based on feather	3.04	67.51±3.25%

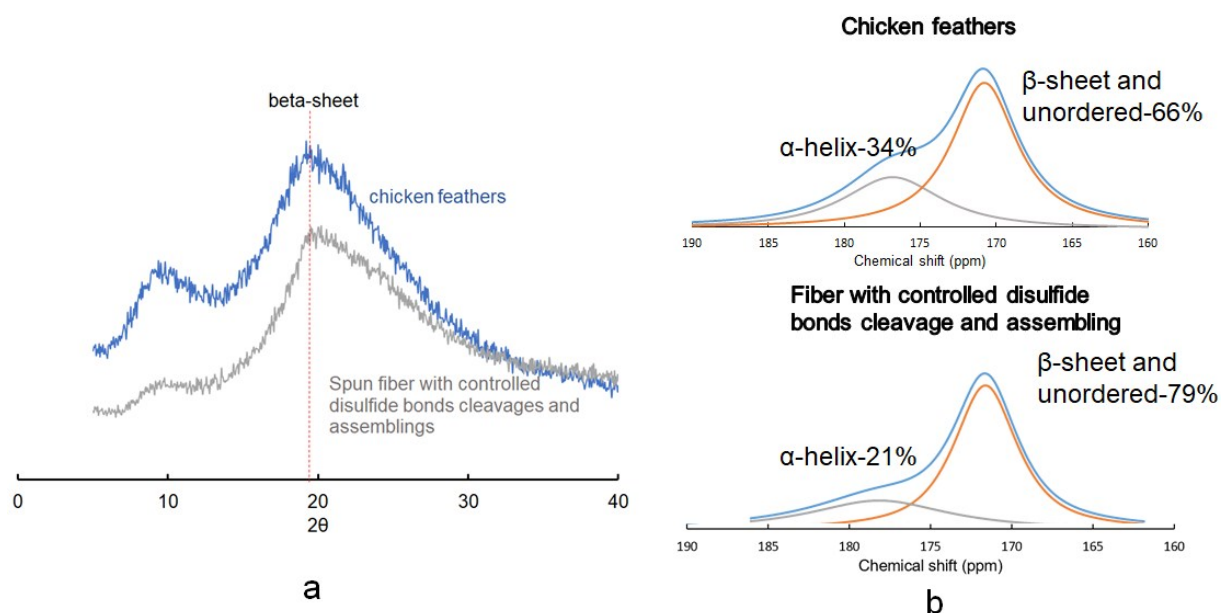


Figure 1 XRD spectra and deconvolutions of the  $^{13}\text{C}$  NMR spectra (around 170 ppm) of chicken feathers and keratin fibers.

The crystallinity values in Table 3 were obtained based on area fittings of crystalline peaks at 9°, 17.8° and 19°, and the amorphous peak at around 20° via Jade 6.0. Total degree of crystallinity was obtained by calculation of the area ratio of crystalline peaks. Crystallinity of  $\alpha$ -helix and  $\beta$ -sheet was obtained by calculation of ratio of peak areas corresponding to  $\alpha$ -helix and  $\beta$ -sheet. The peak at about 9° was assigned to  $\alpha$ -helix and  $\beta$ -sheet while peaks at 17.8° and 19° corresponded to  $\alpha$ -helix and  $\beta$ -sheet structures, respectively. In NMR, the secondary structures of chicken feathers and keratin fibers were analyzed using the chemical shift of carbonyl groups. The deconvolution of carbonyl groups usually results in two peaks at 176 ppm, attributed to  $\alpha$ -helix and 172 ppm, attributed to both random coil and  $\beta$ -sheet conformations.

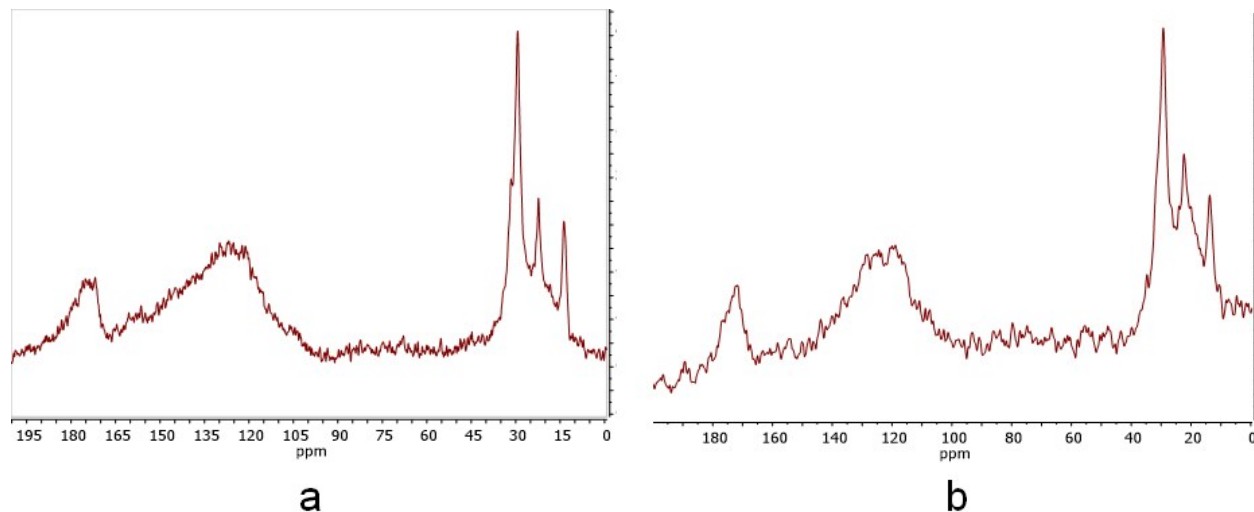


Figure 2. Unmodified solid  $^{13}\text{C}$  NMR spectra of a) chicken feathers and b) spun fibers.

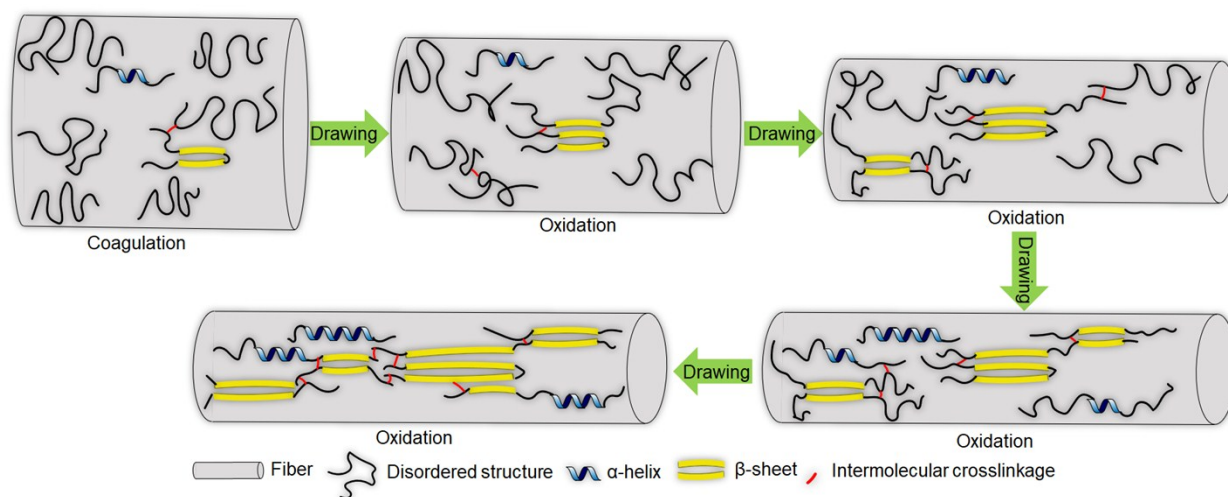


Figure 3 Morphological change in keratin fibers on a continuous spinning line with controlled disulfide bonds assembly

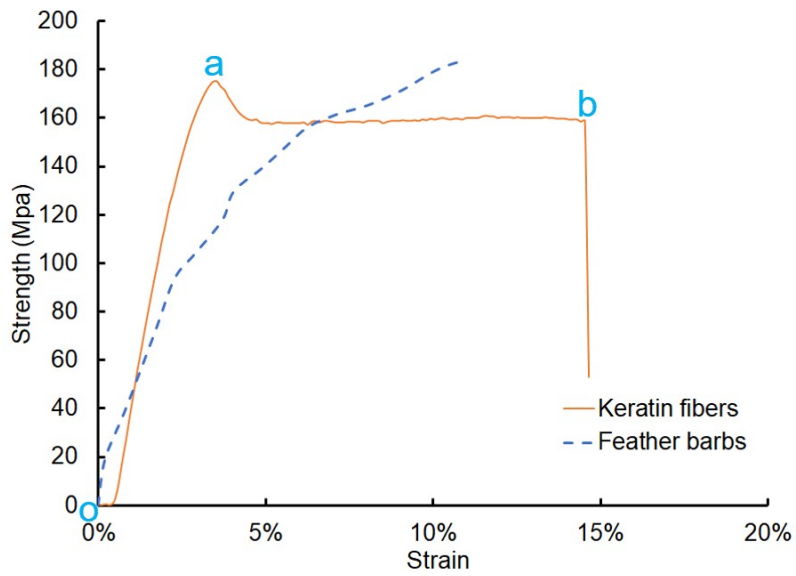


Figure 4 Typical curves for feathers and keratin fibers.

Table 2 Material cost to produce 1kg of pure keratin fibers

	Materials & Chemicals	Unit price (\$/kg) †	Consumption to produce 1 kg of keratin fibers (kg)	Cost (\$)	Total material cost (\$)
Extraction §	Chicken feathers	0 ¶	1.33	0	0.83
	Cysteine	5.5	0.09	0.495	
	Urea & SDS	0.39	0.28	0.11	
	Alkali	0.2	0.20	0.040	
	Hydrochloric acid (31%)	0.10	0.07	0.007	

	Sodium sulfate	0.06	0.08	0.005	
Spinning	Sodium carbonate	0.13	0.016	0.002	
	Sodium dodecyl sulfate	0.9	0.05	0.045	
	Mercaptoethanol	4	0.02	0.08	
	Acetic acid	0.2	0.02	0.004	
	Sodium sulfate	0.17	0.15	0.003	
	Zinc sulfate	0.62	0.05	0.03	
	Oxidants	0.8	0.004	0.003	
	Surfactant	0.3	0.001	0.003	

§ Calculation is based on our previous urea-cysteine based extraction method

† All the prices of chemicals were obtained from Alibaba.com or 1688.com (accessed on 9/30/2019).

¶ Chicken feathers are deemed as wastes and thus could be obtained at no cost.