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APPENDICES

Appendix A Mechanical Properties Data of Chitin and Chitin Nanocomposite Films

Table A1 Mechanical properties data of 1% β -chitin film

| Type of films | Tensile strength (MPa) | Percentage of strain at break (%) | Tensile modulus (MPa) |
|----------------|------------------------|-----------------------------------|-----------------------|
| 1% Chitin pure | 16.204 | 1.161 | 595.305 |
| | 16.406 | 1.27 | 731.776 |
| | 16.571 | 1.313 | 843.962 |
| | 16.639 | 1.365 | 849.697 |
| | 16.672 | 1.432 | 871.575 |
| | 18.038 | 1.542 | 941.524 |
| | 20.689 | 1.698 | 999.217 |
| | 21.274 | 1.747 | 1066.609 |
| | 21.282 | 1.806 | 1102.506 |
| | 23.081 | 2.087 | 1131.633 |
| | 25.198 | 2.143 | 1173.534 |
| | 25.218 | 2.36 | 1228.904 |
| | 26.096 | 2.676 | 1256.884 |
| | 28.741 | 3.022 | 1279.246 |
| | 34.235 | 3.382 | 1292.845 |
| | 35.847 | 3.392 | 1450.247 |
| | 37.397 | 3.724 | 1450.943 |
| | 42.555 | 3.948 | 1497.774 |
| | 44.678 | 3.962 | 1558.33 |
| | 44.819 | 4.423 | 1891.298 |
| | 47.174 | 4.606 | 2147.907 |
| | 47.225 | 4.726 | 2265.345 |
| | 51.229 | 5.142 | 2363.678 |
| | 54.013 | 5.144 | 2619.754 |
| | 58.798 | 5.179 | 3036.804 |
| | 66.256 | 5.686 | 3204.391 |
| 67.704 | 5.815 | 3285.337 | |
| 68.983 | 6.967 | | |
| 69.873 | 11.373 | | |

Table A2 Mechanical properties data of 1% β -chitin + 0.25% α -chitin whisker film

| Type of films | Tensile strength (MPa) | Percentage of strain at break (%) | Tensile modulus (MPa) |
|-------------------------------------|------------------------|-----------------------------------|-----------------------|
| 1% Chitin + 0.25% Chitin whisker | 16.162 | 1.367 | 634.045 |
| | 16.321 | 1.393 | 885.017 |
| | 16.338 | 1.406 | 891.481 |
| | 16.521 | 1.443 | 940.87 |
| | 17.751 | 1.445 | 941.802 |
| | 19.852 | 1.643 | 946.83 |
| | 24.58 | 1.798 | 953.325 |
| | 27.428 | 1.898 | 1077.806 |
| | 30.506 | 1.98 | 1079.392 |
| | 31.448 | 2.383 | 1105.976 |
| | 32.282 | 2.545 | 1159.376 |
| | 36.039 | 2.561 | 1160.498 |
| | 37.251 | 2.629 | 1212.026 |
| | 39.013 | 2.919 | 1276.287 |
| | 39.308 | 3.321 | 1319.191 |
| | 41.14 | 3.365 | 1341.333 |
| | 41.484 | 3.423 | 1523.07 |
| | 41.929 | 3.596 | 1563.232 |
| | 45.635 | 3.797 | 1785.726 |
| | 48.233 | 3.873 | 1904.767 |
| | 51.087 | 3.884 | 1964.94 |
| | 54.942 | 3.993 | 2226.727 |
| | 57.075 | 4.043 | 2305.194 |
| | 57.834 | 4.174 | 2309.991 |
| | 62.423 | 4.648 | 2536.457 |
| | 66.899 | 4.85 | 2665.772 |
| 70.639 | 5.161 | 3020.89 | |
| | 11.141 | 3154.728 | |
| | | 3300.889 | |

Table A3 Mechanical properties data of 1% β -chitin + 0.5% α -chitin whisker film

| Type of films | Tensile strength (MPa) | Percentage of strain at break (%) | Tensile modulus (MPa) |
|------------------------------------|------------------------|-----------------------------------|-----------------------|
| 1% Chitin + 0.5% Chitin whisker | 10.758 | 1.109 | 925.625 |
| | 12.076 | 1.133 | 1188.059 |
| | 12.415 | 1.225 | 1225.349 |
| | 13.2045 | 1.255 | 1244.6 |
| | 13.246 | 1.323 | 1271.299 |
| | 14.611 | 1.352 | 1296.063 |
| | 15.327 | 1.358 | 1300.676 |
| | 15.784 | 1.36 | 1385.764 |
| | 16.931 | 1.546 | 1429.103 |
| | 17.731 | 1.757 | 1457.653 |
| | 18.216 | 1.846 | 1525.692 |
| | 18.295 | 1.859 | 1613.24 |
| | 22.534 | 1.907 | 1647.071 |
| | 25.872 | 2.299 | 1733.961 |
| | 28.53 | 2.308 | 1751.817 |
| | 28.612 | 2.398 | 1810.792 |
| | 28.633 | 2.446 | 1819.11 |
| | 30.017 | 2.672 | 1852.605 |
| | 30.743 | 2.778 | 1913.104 |
| | 33.078 | 2.911 | 2060.86 |
| | 33.978 | 3.091 | 2100.992 |
| | 39.505 | 3.202 | 2138.653 |
| | 44.276 | 3.6 | 2237.858 |
| | 44.368 | 3.72 | 2318.247 |
| | 44.419 | 3.918 | 2391.426 |
| | 46.435 | 4.278 | 2427.722 |
| | 48.306 | 4.8 | 2497.311 |
| | 50.302 | 4.946 | 2516.89 |
| | 50.782 | 5.011 | 2520.408 |
| | 54.738 | 5.412 | 2532.556 |
| 55.443 | 6.323 | 3118.642 | |
| 59.536 | 6.49 | 3581.833 | |
| 66.322 | 7.422 | 3993.366 | |
| 70.682 | 7.566 | | |

Table A4 Mechanical properties data of 1% β -chitin + 0.75% α -chitin whisker film

| Type of films | Tensile strength (MPa) | Percentage of strain at break (%) | Tensile modulus (MPa) |
|-------------------------------------|------------------------|-----------------------------------|-----------------------|
| 1% Chitin + 0.75% Chitin whisker | 12.863 | 1.079 | 1205.777 |
| | 13.614 | 1.081 | 1225.204 |
| | 14.888 | 1.147 | 1298.493 |
| | 14.905 | 1.262 | 1374.675 |
| | 15.374 | 1.42 | 1404.143 |
| | 16.213 | 1.469 | 1416.901 |
| | 17.436 | 1.482 | 1552.973 |
| | 19.946 | 1.521 | 1555.565 |
| | 20.828 | 1.554 | 1577.567 |
| | 21.321 | 1.604 | 1620.145 |
| | 22.96 | 1.67 | 1776.926 |
| | 23.658 | 1.676 | 1809.743 |
| | 24.89 | 1.724 | 1815.236 |
| | 28.708 | 1.74 | 1870.58 |
| | 31.538 | 1.74 | 1870.846 |
| | 32.13 | 1.835 | 1879.32 |
| | 33.401 | 1.874 | 1958.542 |
| | 33.605 | 1.883 | 2009.907 |
| | 33.678 | 2.095 | 2073.504 |
| | 35.176 | 2.24 | 2143.931 |
| | 38.333 | 2.261 | 2192.451 |
| | 39.368 | 2.303 | 2203.426 |
| | 43.716 | 2.494 | 2205.257 |
| | 49.834 | 2.574 | 2218.078 |
| | 56.798 | 2.812 | 2224.335 |
| | 61.036 | 3.05 | 2324.024 |
| | 66.075 | 3.116 | 2332.0717 |
| | 66.861 | 3.718 | 2466.261 |
| | 67.947 | 3.967 | 2551.313 |
| | 70.764 | 5.443 | 2626.866 |
| 73.931 | 5.45 | 2634.169 | |
| 82.023 | 5.842 | 2724.309 | |
| | 6.131 | 2903.082 | |
| | 6.435 | 3157.956 | |

Table A5 Mechanical properties data of 1% β -chitin + 1% α -chitin whisker film

| Type of films | Tensile strength (MPa) | Percentage of strain at break (%) | Tensile modulus (MPa) |
|-------------------------------|------------------------|-----------------------------------|-----------------------|
| 1% Chitin + 1% Chitin whisker | 14.807 | 1.198 | 1322.97 |
| | 15.246 | 1.315 | 1328.352 |
| | 16.246 | 1.318 | 1361.892 |
| | 16.961 | 1.42 | 1411.442 |
| | 20.144 | 1.427 | 1570.39 |
| | 20.438 | 1.548 | 1637.46 |
| | 25.058 | 1.641 | 1790.876 |
| | 25.13 | 1.647 | 1802.519 |
| | 25.665 | 1.671 | 1834.193 |
| | 27.218 | 1.696 | 1853.068 |
| | 27.7 | 1.733 | 1869.116 |
| | 27.734 | 1.846 | 1898.414 |
| | 28.166 | 1.994 | 1955.355 |
| | 28.61 | 2.054 | 1973.791 |
| | 29.194 | 2.11 | 1981.071 |
| | 29.652 | 2.126 | 2005.745 |
| | 29.705 | 2.549 | 2031.454 |
| | 31.282 | 2.657 | 2090.433 |
| | 32.362 | 2.676 | 2103.305 |
| | 32.558 | 2.766 | 2187.94 |
| | 32.807 | 3.28 | 2213.44 |
| | 32.822 | 3.477 | 2267.007 |
| | 33.155 | 3.712 | 2298.618 |
| | 35.266 | 3.732 | 2316.594 |
| | 38.869 | 3.891 | 2444.023 |
| | 39.109 | 4.166 | 2489.41 |
| | 47.931 | 4.279 | 2595.505 |
| 50.819 | 5.13 | 2656.032 | |
| 52.992 | 5.361 | 2736.868 | |
| 63.707 | 5.42 | 2776.837 | |
| 67.871 | 6.17 | 2903.79 | |
| 71.994 | 7.637 | 3013.84 | |
| 73.991 | | | |
| 75.666 | | | |

Table A6 Mechanical properties data of 1% β -chitin + 1.5% α -chitin whisker film

| Type of films | Tensile strength (MPa) | Percentage of strain at break (%) | Tensile modulus (MPa) |
|------------------------------------|------------------------|-----------------------------------|-----------------------|
| 1% Chitin + 1.5% Chitin whisker | 24.657 | 1.335 | 1438.207 |
| | 25.802 | 1.47 | 1596.485 |
| | 27.221 | 1.482 | 1714.256 |
| | 27.603 | 1.496 | 1731.014 |
| | 27.794 | 1.498 | 1821.748 |
| | 29.346 | 1.541 | 1824.421 |
| | 29.968 | 1.599 | 1880.869 |
| | 30.098 | 1.776 | 2134.348 |
| | 30.68 | 1.7931 | 2267.647 |
| | 31.094 | 1.883 | 2412.852 |
| | 31.418 | 1.948 | 2443.643 |
| | 32.399 | 1.99 | 2445.146 |
| | 33.924 | 2.001 | 2533.231 |
| | 34.042 | 2.149 | 2655.655 |
| | 35.79 | 2.296 | 2703.994 |
| | 35.991 | 2.558 | 2886.842 |
| | 37.161 | 2.569 | 3203.845 |
| | 37.592 | 2.617 | 3335.218 |
| | 38.271 | 2.999 | 3366.266 |
| | 39.942 | 3.084 | 3411.22 |
| | 51.495 | 3.536 | 3447.74 |
| | 57.226 | 3.5805 | 3452.859 |
| | 58.006 | 3.5845 | 3460.706 |
| | 63.639 | 3.6764 | 3520.094 |
| | 64.417 | 3.7345 | 3521.04 |
| | 65.716 | 3.784 | 3546.023 |
| 68.133 | 3.8335 | 3642.137 | |
| 80.36 | 4.185 | 3669.808 | |
| | 4.855 | 3859.654 | |

Table A7 Mechanical properties data of 1% β -chitin + 2% α -chitin whisker film

| Type of films | Tensile strength (MPa) | Percentage of strain at break (%) | Tensile modulus (MPa) |
|-------------------------------|------------------------|-----------------------------------|-----------------------|
| 1% Chitin + 2% Chitin whisker | 18.988 | 1.205 | 1419.043 |
| | 19.287 | 1.587 | 1421.816 |
| | 20.783 | 1.642 | 1557.321 |
| | 21.001 | 1.938 | 1569.336 |
| | 21.584 | 2.188 | 1590.356 |
| | 22.732 | 2.212 | 1674.172 |
| | 24.468 | 2.309 | 1771.878 |
| | 25.43 | 2.336 | 1781.294 |
| | 25.728 | 2.519 | 1910.559 |
| | 26.883 | 2.5425 | 1995.672 |
| | 27.068 | 4.542 | 2058.462 |
| | 27.486 | 4.578 | 2149.229 |
| | 28.138 | 4.663 | 2160.472 |
| | 29.747 | 5.001 | 2161.074 |
| | 29.952 | 5.031 | 2218.786 |
| | 30.928 | 5.4091 | 2275.19 |
| | 31.824 | 5.561 | 2316.114 |
| | 32.711 | 5.606 | 2360.09 |
| | 33.993 | 5.686 | 2391.583 |
| | 34.339 | 5.748 | 2419.49 |
| | 35.921 | 6.176 | 2430.375 |
| | 37.37 | 6.658 | 2447.534 |
| | 42.459 | 6.696 | 2489.603 |
| | 50.665 | 7.286 | 2591.504 |
| 51.234 | 7.438 | 2675.762 | |
| 52.909 | | 2714.606 | |
| 54.93 | | 3397.596 | |
| 60.192 | | | |
| 60.616 | | | |

Appendix B % Swelling Data of Chitin and Chitin Nanocomposite Films

Table B1 % Swelling data of 1% β -chitin film

| Type of films | % Swelling | | | | | | | |
|---------------|------------|----------|----------|----------|----------|----------|----------|----------|
| | 5 min | 10 min | 15 min | 30 min | 60 min | 90 min | 120 min | 180 min |
| 1% | 30.51546 | 32.06107 | 43.85027 | 37.77293 | 44.86957 | 19.59361 | 52.22672 | 21.0989 |
| Chitin | 31.51079 | 38.59649 | 47.99499 | 50.96322 | 50.3055 | 20 | 53.14685 | 46.57795 |
| pure | 31.91489 | 44.79638 | 48.73188 | 53.17073 | 50.47821 | 25.52783 | 54.76673 | 53.27103 |
| | 33.44316 | 46.22905 | 50 | 57.16586 | 59.80231 | 34.92586 | 60.28881 | 61.17851 |
| | 34.44976 | 49.8829 | 51.40187 | 62.10046 | 62.11849 | 46.92443 | 62.13768 | 62.2449 |
| | 44.08867 | 56.97446 | 57.18433 | 67.88009 | 62.35294 | 67.25522 | 62.17458 | 62.9845 |
| | 49.04679 | 61.22754 | 65.10172 | 69.90291 | 66.20553 | 70.11494 | 62.66667 | 66.1157 |
| | 51.05882 | 63.21839 | 65.17413 | 70.09346 | 68.50282 | 70.3259 | 64.40397 | 70.54795 |
| | 53.32031 | 67.11656 | 65.18405 | 70.68702 | 74.91909 | 78.91654 | 65.47812 | 73.03371 |
| | 60.63536 | 67.79661 | 66.08696 | 72.92929 | 75.80071 | 81.09091 | 75.10288 | 73.99577 |
| | 67.25979 | 68.21306 | 84.14873 | 75.25424 | 76.02564 | 84.67153 | 77.25806 | 77.34977 |
| | 70.23411 | 68.22742 | 89.53688 | 77.18919 | 81.46912 | 88.90086 | 88.17035 | 78.83495 |
| | 71.88498 | 70.29221 | 91.10512 | 78.8296 | 82.36273 | 92.43243 | 93.35828 | 80.3943 |
| | 74.677 | 73.4104 | 93.64919 | 90.90909 | 102.585 | 92.89256 | 98.30508 | 91.95751 |
| | 79.52872 | 78.53774 | 94.3662 | | 134.7594 | 97.50446 | 99.35345 | 94.68268 |

Table B2 % Swelling data of 1% β -chitin + 0.5% α -chitin whisker film

| Type of films | % Swelling | | | | | | | |
|---------------|------------|----------|----------|----------|----------|----------|----------|----------|
| | 5 min | 10 min | 15 min | 30 min | 60 min | 90 min | 120 min | 180 min |
| 1% | 15.53398 | 9.576837 | 17.94872 | 25.5102 | 13.91753 | 24.54361 | 27.2549 | 17.70245 |
| Chitin | 19.29047 | 14.21569 | 28.37573 | 26.38191 | 28.02057 | 27.65568 | 30.05051 | 19.77186 |
| pure | 20.09685 | 21.44928 | 30.14706 | 31.54671 | 29.92 | 44.5 | 33.93939 | 38.03056 |
| + 0.5% | 23.72372 | 24.30341 | 31.10599 | 32.54438 | 34.7432 | 46.74385 | 34.9353 | 40.42553 |
| Chitin | 25.92122 | 29.54545 | 34.12921 | 37.3444 | 36.953 | 47.48428 | 37.70492 | 43.15515 |
| whisker | 28.54701 | 32.03125 | 35.59322 | 42.53394 | 38.54015 | 48.22335 | 39.83051 | 43.86364 |
| | 28.54914 | 32.94893 | 37.42802 | 43.63104 | 38.61386 | 50.37975 | 46.23288 | 46.15385 |
| | 36.96884 | 34.50135 | 39.01408 | 46.00551 | 40.85258 | 51.90259 | 48.41689 | 49.59893 |
| | 37.30159 | 34.82906 | 40.35948 | 49.14286 | 41.43302 | 52.55732 | 50.50167 | 56.07235 |
| | 39.60396 | 42.13918 | 41.37931 | 52.84178 | 43.10345 | 57.08556 | 50.63291 | 56.43045 |
| | 39.748 | 42.66442 | 49.46004 | 53.44418 | 43.69369 | 58.88158 | 51.02975 | 59.25156 |
| | 44.96644 | 47.07904 | 53.16092 | 60.04016 | 46.03448 | 58.90152 | 55.22042 | 67.13615 |
| | 48.0663 | 48.08081 | 53.44564 | 61.89655 | 52.27882 | 59.01288 | 57.90698 | 68.26156 |
| | 48.94895 | 58.02817 | 57.74278 | 76.32979 | 53.1401 | 61.13903 | 66.15646 | 79.08012 |
| | 52.53456 | 62.76921 | 58.28571 | 78.46154 | 64.07767 | 63.88467 | 67.80627 | 105.045 |

Table B3 % Swelling data of 1% β -chitin + 1% α -chitin whisker film

| Type of films | % Swelling | | | | | | | |
|---------------|------------|----------|----------|----------|----------|----------|----------|----------|
| | 5 min | 10 min | 15 min | 30 min | 60 min | 90 min | 120 min | 180 min |
| 1% | 15.53398 | 9.576837 | 30.14706 | 25.5102 | 28.02057 | 24.54361 | 30.05051 | 17.70245 |
| Chitin | 23.72372 | 14.21569 | 31.10599 | 26.38191 | 36.953 | 27.65568 | 37.70492 | 19.77186 |
| pure | 24.47449 | 21.44928 | 35.84656 | 31.54671 | 40.85258 | 34.03315 | 39.83051 | 40.42553 |
| + 1% | 31.96622 | 29.54545 | 40.35948 | 32.54438 | 41.43302 | 44.16136 | 45.01916 | 43.15515 |
| Chitin | 35.39326 | 32.94893 | 43.77312 | 37.89809 | 53.87755 | 46.54088 | 49.5471 | 59.63115 |
| whisker | 36.96884 | 33.45588 | 45.8891 | 39.84716 | 54.89467 | 54.85714 | 50.50167 | 60.35242 |
| | 38.54167 | 35.5315 | 49.02597 | 43.125 | 55.3681 | 57.08556 | 52.13675 | 65.08728 |
| | 39.60396 | 35.53719 | 49.46004 | 44.88978 | 56.00858 | 61.00386 | 54.57227 | 65.52301 |
| | 39.748 | 37.02602 | 50.07194 | 45.3668 | 57.39645 | 61.13903 | 56.8521 | 70.07964 |
| | 39.9137 | 40.93319 | 50.501 | 45.70136 | 64.07767 | 61.43123 | 57.90698 | 75.27233 |
| | 40.20725 | 49.21105 | 50.5314 | 46.00551 | 72.99169 | 63.88467 | 77.43491 | 76.87688 |
| | 41.79104 | 50.85085 | 53.10421 | 47.34607 | 73.11828 | 68.82716 | 78.48223 | 82.02934 |
| | 42.54254 | 55.625 | 56.60731 | 53.12821 | 74.01869 | 74.03141 | 81.08776 | 85.71429 |
| | 44.34088 | 57.14286 | 58.28571 | 59.01639 | 74.07407 | 88.59857 | 83.06709 | 105.045 |
| | 48.75445 | 61.04651 | 60.1683 | 60.26846 | 86.80124 | 90.77922 | 90.57789 | 107.1038 |

Table B4 % Swelling data of 1% β -chitin + 2% α -chitin whisker film

| Type of films | % Swelling | | | | | | | |
|---------------|------------|----------|----------|----------|----------|----------|----------|----------|
| | 5 min | 10 min | 15 min | 30 min | 60 min | 90 min | 120 min | 180 min |
| 1% | 14.12776 | 8.414634 | 26.02871 | 21.8107 | 25.76754 | 31.08935 | 25.68421 | 20.39397 |
| Chitin | 14.89362 | 17.1627 | 30.48226 | 26.08696 | 34.06814 | 31.4978 | 25.84388 | 26.71684 |
| pure | 16.28788 | 20.59925 | 33.43434 | 26.87366 | 34.57596 | 34.65982 | 27.47368 | 34.55818 |
| + 2% | 18.26923 | 21.54171 | 36.00406 | 26.90763 | 39.30085 | 35.64453 | 31.2369 | 34.58418 |
| Chitin | 20.02237 | 27.92608 | 36.15702 | 27.94971 | 39.8524 | 36.63751 | 33.61111 | 34.85601 |
| whisker | 20.84623 | 29.82005 | 36.87708 | 29.01961 | 40.94356 | 36.70103 | 33.96437 | 39.81832 |
| | 24.47552 | 30.1477 | 37.07627 | 29.26186 | 41.39229 | 37.04044 | 34.14179 | 40.32724 |
| | 25.90286 | 31.56146 | 37.46065 | 31.18581 | 43.53059 | 37.12121 | 37.00397 | 43.9318 |
| | 26.69456 | 33.56461 | 39.27626 | 34.99511 | 45.90164 | 37.24435 | 38.88889 | 45.46403 |
| | 28.10903 | 33.82187 | 40.69498 | 35.05355 | 46.65992 | 38.13016 | 43.87435 | 45.98639 |
| | 30.86854 | 34.62783 | 41.14528 | 45.24715 | 55.09554 | 38.23272 | 54.34381 | 46.875 |
| | 34.67909 | 36.40719 | 41.22713 | 47.2044 | 55.97417 | 38.43537 | 55.04359 | 49.60474 |
| | 34.6798 | 37.98303 | 41.57187 | 49.18348 | 56.02755 | 39.86867 | 55.66893 | 49.93084 |
| | 39.57845 | 42.79523 | 41.69788 | 53.76344 | 56.61376 | 40.23211 | 63.909 | 52.10991 |
| | 40.61538 | 44.08163 | 42.68293 | 53.97317 | 57.04082 | 44.06639 | 64.77644 | 56.03751 |

Appendix C Biodegradability (% Weight loss) Data of Chitin and Chitin Nanocomposite Films

Table C1 Biodegradability (% Weight loss) data of 1% β -chitin film

| Type of films | % Weight loss after enzymatic hydrolysis | | | | | | |
|----------------|--|----------|----------|----------|----------|----------|----------|
| | 1 day | 2 days | 3 days | 4 days | 5 days | 6 days | 7 days |
| 1% Chitin pure | 8.449396 | 12.62767 | 23.12073 | 34.26184 | 41.87558 | 49.95357 | 60.07428 |
| | 8.883827 | 12.64237 | 26.27669 | 37.70076 | 50.21911 | 54.87013 | 67.09154 |
| | 10.72727 | 20.62553 | 29.01554 | 41.27958 | 51.08225 | 56.1658 | 67.56477 |
| | 11.86736 | 21.56004 | 35.16484 | 42.27979 | 53.26425 | 57.2305 | 70.37686 |
| | 13.75546 | 25.18195 | 36.3716 | 45.10251 | 54.18428 | 58.36972 | 72.12518 |
| | 16.48352 | 28.96871 | 36.96408 | 45.88644 | 54.94905 | 60.48667 | 77.36364 |
| | 16.89119 | 33.36245 | 38.25328 | 45.88745 | 57.1263 | 68.72727 | 85.41485 |
| | 18.07648 | 33.45455 | 39.08297 | 47.67103 | 64.36364 | 77.90433 | 86.55959 |
| | 19.45662 | 34.09091 | 41.09091 | 52.18182 | 67.31207 | 78.51528 | 92.8246 |
| | 21.8845 | 34.30052 | 42.85714 | 54.71125 | 72.79635 | 79.62806 | 93.31307 |
| | 24.45887 | 46.42234 | 51.3089 | 60.38394 | 74.06114 | 90.04559 | 93.4555 |
| | 28.9083 | 50.07599 | 53.87538 | 61.48472 | 84.64223 | 91.01222 | |
| | | | | | 90.04559 | | |
| | | | | | 91.01222 | | |

Table C2 Biodegradability (% Weight loss) data of 1% β -chitin + 0.5% chitin whisker film

| Type of films | % Weight loss after enzymatic hydrolysis | | | | | | |
|---------------------------------------|--|----------|----------|----------|----------|----------|----------|
| | 1 day | 2 days | 3 days | 4 days | 5 days | 6 days | 7 days |
| 1% Chitin + 0.5% Chitin whisker | 3.535912 | 13.03867 | 18.57143 | 29.23077 | 37.31618 | 38.51103 | 40.38835 |
| | 6.539235 | 14.94505 | 25.73529 | 33.86642 | 37.47573 | 39.2233 | 44.39338 |
| | 8.02139 | 18.41046 | 27.16298 | 34.46602 | 39.4385 | 42.44652 | 46.39037 |
| | 9.56044 | 19.71925 | 28.05825 | 34.92647 | 39.79304 | 50.11304 | 50.79126 |
| | 11.85662 | 21.06716 | 29.77941 | 35.22727 | 47.48491 | 51.00604 | 52.7163 |
| | 12.3789 | 22.03883 | 31.7968 | 39.59445 | 48.30445 | 67.38906 | 76.57379 |
| | 14.62741 | 22.70221 | 33.83138 | 41.34809 | 52.94118 | 82.76243 | 83.63123 |
| | 15.33981 | 23.51834 | 34.25414 | 44.27245 | 55.69061 | 86.26529 | 85.27473 |
| | 17.87394 | 24.21959 | 34.26213 | 47.02336 | 57.03297 | 88.68132 | 85.63536 |
| | 20.8111 | 25.08004 | 36.81378 | 47.73481 | 79.93597 | 89.22092 | 89.86126 |
| | 25.24491 | 27.76058 | 36.98252 | 84.28418 | 80.62433 | 90.31216 | 91.49623 |
| | 25.387 | 30.74604 | 40.76865 | 89.14443 | 94.57222 | 98.71205 | |

Table C3 Biodegradability (% Weight loss) data of 1% β -chitin + 1% chitin whisker film

| Type of films | % Weight loss after enzymatic hydrolysis | | | | | | |
|-------------------------------------|--|----------|----------|----------|----------|----------|----------|
| | 1 day | 2 days | 3 days | 4 days | 5 days | 6 days | 7 days |
| 1% Chitin + 1% Chitin whisker | 3.02795 | 4.658385 | 8.152174 | 15.83851 | 24.45652 | 27.93478 | 28.91304 |
| | 3.35152 | 5.144193 | 17.24416 | 17.06937 | 25.92391 | 36.80089 | 40.71588 |
| | 4.016064 | 7.46988 | 17.67068 | 21.59549 | 31.56664 | 40.04341 | 41.88823 |
| | 4.026846 | 11.12975 | 20.76087 | 22.48996 | 32.94048 | 46.19918 | 50.3241 |
| | 5.303477 | 14.02095 | 20.7635 | 22.53259 | 34.95526 | 56.88961 | 74.6988 |
| | 7.228261 | 14.61825 | 20.8613 | 24.02174 | 36.57081 | 64.61419 | 75.1364 |
| | 9.669621 | 15.43478 | 26.39527 | 31.76734 | 49.53445 | 68.81156 | 75.62112 |
| | 9.776536 | 17.13723 | 26.58709 | 35.52799 | 52.69944 | 78.8755 | 75.74537 |
| | 11.72002 | 20.45578 | 26.94107 | 35.6484 | 54.76034 | 79.27019 | 77.21602 |
| | 12.01576 | 23.19925 | 27.22451 | 51.47735 | 64.49799 | 92.83054 | 87.80261 |
| | 20.39289 | 25.16205 | 48.40708 | | | | |
| | 44.86726 | 46.54867 | 89.3219 | | | | |

Table C4 Biodegradability (% Weight loss) data of 1% β -chitin + 0.5% chitin whisker film

| Type of films | % Weight loss after enzymatic hydrolysis | | | | | | |
|-------------------------------------|--|----------|----------|----------|----------|----------|----------|
| | 1 day | 2 days | 3 days | 4 days | 5 days | 6 days | 7 days |
| 1% Chitin + 2% Chitin whisker | 1.169265 | 1.781737 | 8.184855 | 11.97105 | 15.95916 | 24.3215 | 30.58462 |
| | 3.653949 | 7.539267 | 11.44546 | 14.23966 | 20.36649 | 27.01571 | 38.8309 |
| | 4.553846 | 8.436325 | 12.98429 | 14.66025 | 22.13916 | 28.27119 | 39.73822 |
| | 6.440678 | 9.353846 | 13.30898 | 16.90627 | 22.18163 | 30.33846 | 45.08329 |
| | 6.492147 | 10.23577 | 13.72308 | 17.01571 | 22.52308 | 31.70339 | 48.10059 |
| | 7.130535 | 10.90814 | 16.10121 | 17.69311 | 22.57627 | 38.75278 | 55.70209 |
| | 7.515658 | 13.28814 | 18.37288 | 20.61538 | 26.64865 | 43.23167 | 63.35135 |
| | 7.920059 | 14.58179 | 18.57883 | 21.22034 | 33.01231 | 51.20248 | 82.00115 |
| | 11.7175 | 15.46281 | 22.8979 | 24.77477 | 33.18486 | 72.32432 | 94.26503 |
| | 12.83784 | 17.30023 | 24.05405 | 25.78378 | 35.88589 | 81.71363 | |
| | 13.96431 | 17.71772 | 32.5834 | 33.82467 | 43.44453 | | |
| | 18.43243 | 20.37838 | 38.04173 | | | | |

Appendix D Absorbance Data in Various Concentrations for Cytotoxicity Test by MTT Assay of Chitin and Chitin Nanocomposite Films

| Sample | Concentration | Absorbance value |
|--------|---------------|--|
| Ch1 | 1 | 0.659 0.625 0.645 0.661 0.586 0.565 0.588 0.578 |
| Ch 2 | 0.5 | 0.586 0.578 0.616 0.604 0.592 0.591 0.641 0.568 |
| Ch 3 | 0.25 | 0.667 0.521 0.524 0.599 0.68 0.633 0.652 0.68 |
| Ch 4 | 0.125 | 0.636 0.652 0.643 0.598 0.63 0.616 0.596 0.664 |

| | | |
|------|-----------|--|
| Ch 5 | 0.063 | 0.557 0.603 0.673 0.601 0.587 0.598 0.563 0.532 |
| Ch 6 | 0.031 | 0.602 0.67 0.744 0.69 0.647 0.68 0.671 0.683 |
| Ch 7 | 0.016 | 0.426 0.584 0.727 0.661 0.668 0.593 0.631 0.592 |
| Ch 8 | 0.008 | 0.602 0.657 0.716 0.69 0.708 0.669 0.659 0.654 |
| Ct 1 | control 1 | 0.719 0.792 0.692 0.696 0.688 0.689 0.604 |

| | | |
|------|-----------|---|
| | | 0.649 |
| Ct 2 | control 2 | 0.666 0.733 0.772 0.717 0.752 0.65 0.651 0.665 |

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