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Analysis of *Caenorhabditis elegans* via Bioinformatics Approaches Basis on their Precursors Statistics Values

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Abstract

MicroRNA (miRNA) are a class of small regulatory non coding RNAs. These are about 21 to 25 nucleotides in length. Analysis of miRNA is leading to new paradigms for control of gene expression during plants and animals. Most noncoding RNAs are characterized by a specific secondary structures that determine their function. In present study we determine the minimum free energy (MFE) of *C. elegans* precursor's sequences. That retrieves from mirBASE.

Keywords MicroRNA; *C. elegans*; Minimum free energy (MFE); Noncoding; Transcriptional regulators; Ribonuclease III

Introduction

Micro RNA regulates gene expression. miRNAs are well conserved in both plants and animals, and are thought to be a vital and evolutionarily ancient component of genetic regulation [1]. Mature microRNAs (miRNAs) are a class of naturally occurring small non-coding RNA molecules; about 21 to 25 nucleotides in length. MicroRNAs are partially complementary to one or more messenger RNA (mRNA) molecules and their main function is to down- regulate gene expression in a variety of manners, including translational repression, mRNA cleavage and deadenylation [2]. miRNAs are a class of post-transcriptional regulators [3]. Most non-coding RNAs are characterized by a specific secondary and tertiary structure that determines their function.

Analysis of miRNAs is leading to new paradigms for control of gene expression during development in plants and animals. MiRNAs arise from larger precursor molecules that can fold into a stable stem-loop structure [4-8]. Those structures are processed by ribonuclease III-like nuclease Dicer in animals and Dicer like in plants and all have a typical stem-loop shape [4-11].

In present study we predicted the minimum free energy (MFE) values of secondary structures of noncoding RNA sequences, such as microRNA precursors of *C. elegans* with the help of computational software miRBase.

Methodology

The precursors (pre-miRNA) sequences of *C. elegans* were retrieved from miRBase and then go for secondary structure with optimal minimum free energy [12]. Optimal minimum free energy was found out with the help of RNA fold web servers (http://rna.tbi.univie.ac.at) then retrieve the sequence of miRNA from miRBase. Present study which is exclusively based on in silico firstly retrieves precursor sequences from miRBase and then retrieve sequence is submitted in RNA fold web server for minimum free energy values and calculated the minimum free energy for objective analysis [13].

S.No.	Precursor Accession No.	Free energy of thermodynamics	Frequency of MFE structure	Ensenbled diversity	Minimum free energy of centeriod secondary structure	Optimal secondary structure minimum free energy
1	>cel-let-7 MI0000001	-43.63 kcal/mol	6.09%	9.04	-37.90 kcal/mol	-41.90 kcal/mol
2	>cel-lin-4 MI0000002	-41.20 kcal/mol	8.80%	7.90	-39.60 kcal/mol	-39.70 kcal/mol
3	>cel-mir-1 MI0000003	-40.09 kcal/mol	62.68%	1.40	-39.80 kcal/mol	-39.80 kcal/mol
4	>cel-mir-2 MI0000004	-38.30 kcal/mol	6.30%	6.21	-35.40 kcal/mol	-36.60 kcal/mol
5	>cel-mir-34 MI0000005	-36.47 kcal/mol	9.16%	6.53	-35.00 kcal/mol	-35.00 kcal/mol
6	>cel-mir-35 MI0000006	-54.07 kcal/mol	28.84%	5.76	-50.50 kcal/mol	-53.30 kcal/mol
7	>cel-mir-36 MI0000007	-50.93 kcal/mol	7.15%	4.73	-48.40 kcal/mol	-49.30 kcal/mol

8	>cel-mir-37 MI0000008	-43.70 kcal/mol	16.70%	3.06	-42.60 kcal/mol	-42.60 kcal/mol
9	>cel-mir-38 MI0000009	-49.47 kcal/mol	4.06%	7.27	-47.50 kcal/mol	-47.50 kcal/mol
10	>cel-mir-39 MI0000010	-44.12 kcal/mol	16.28%	3.45	-43.00 kcal/mol	-43.00 kcal/mol
11	>cel-mir-40 MI0000011	-46.35 kcal/mol	29.44%	2.61	-45.60 kcal/mol	-45.60 kcal/mol
12	>cel-mir-41 MI0000012	-41.95 kcal/mol	29.48%	9.07	-41.20 kcal/mol	-41.20 kcal/mol
13	>cel-mir-42 MI0000013	-41.91 kcal/mol	14.00%	4.63	-38.10 kcal/mol	-40.70 kcal/mol
14	>cel-mir-43 MI0000014	-47.24 kcal/mol	18.65%	4.27	-46.20 kcal/mol	-46.20 kcal/mol
15	>cel-mir-44 MI0000015	-44.32 kcal/mol	5.18%	8.74	-38.10 kcal/mol	-42.50 kcal/mol
16	>cel-mir-45 MI0000016	-42.70 kcal/mol	37.73%	4.26	-42.10 kcal/mol	-42.10 kcal/mol
17	>cel-mir-46 MI0000017	-40.52 kcal/mol	10.03%	12.08	-39.10 kcal/mol	-39.10 kcal/mol
18	>cel-mir-47 MI0000018	-42.03 kcal/mol	41.98%	4.90	-41.50 kcal/mol	-41.50 kcal/mol
19	>cel-mir-48 MI0000019	-34.68 kcal/mol	14.65%	5.36	-33.10 kcal/mol	-33.50 kcal/mol
20	>cel-mir-49 MI0000020	-38.97 kcal/mol	17.61%	4.69	-37.70 kcal/mol	-37.90 kcal/mol
21	>cel-mir-50 MI0000021	-61.30 kcal/mol	8.75%	5.84	-59.80 kcal/mol	-59.80 kcal/mol
22	>cel-mir-51 MI0000022	-34.90 kcal/mol	0.40%	5.53	-33.30 kcal/mol	-31.50 kcal/mol
23	>cel-mir-52 MI0000023	-26.80 kcal/mol	2.82%	7.58	-24.50 kcal/mol	-24.60 kcal/mol
24	>cel-mir-53 MI0000024	-31.59 kcal/mol	10.46%	6.92	-30.20 kcal/mol	-30.20 kcal/mol
25	>cel-mir-54 MI0000025	-35.03 kcal/mol	6.00%	8.56	-31.00 kcal/mol	-33.30 kcal/
26	>cel-mir-55 MI0000026	-35.63 kcal/mol	15.91%	7.79	-34.50 kcal/mol	-34.50 kcal/mol
27	>cel-mir-56 MI0000027	-42.07 kcal/mol	15.09%	5.96	-38.80 kcal/mol	-40.90 kcal/mol
28	>cel-mir-57 MI0000028	-32.39 kcal/mol	27.97%	5.52	-31.60 kcal/mol	-31.60 kcal/mol
29	>cel-mir-58a MI0000029	-37.29 kcal/mol	10.42%	8.52	-35.60 kcal/mol	-35.90 kcal/mol
30	>cel-mir-59 MI0000030	-36.94 kcal/mol	15.65%	7.37	-33.30 kcal/mol	-35.80 kcal/mol
31	>cel-mir-60 MI0000031	-36.59 kcal/mol	3.38%	9.31	-33.30 kcal/mol	-34.50 kcal/mol
32	>cel-mir-61 MI0000032	-52.19 kcal/mol	6.45%	5.23	-50.50 kcal/mol	-50.50 kcal/mol
33	>cel-mir-63 MI0000034	-38.66 kcal/mol	24.84%	5.78	-37.80 kcal/mol	-37.80 kcal/mol
34	>cel-mir-64 MI0000035	-37.69 kcal/mol	6.45%	9.76	-31.40 kcal/mol	-36.00 kcal/mol
35	>cel-mir-65 MI0000036	-42.68 kcal/mol	33.35%	2.72	-42.00 kcal/mol	-42.00 kcal/mol
36	>cel-mir-66 MI0000037	-39.16 kcal/mol	34.08%	2.53	-38.50 kcal/mol	-38.50 kcal/mol
37	>cel-mir-67 MI0000038	-32.72 kcal/mol	8.45%	5.96	-31.20 kcal/mol	-31.20 kcal/mol
38	>cel-mir-70 MI0000041	-32.88 kcal/mol	17.40%	5.12	-31.10 kcal/mol	-31.80 kcal/mol
39	>cel-mir-71 MI0000042	-37.50 kcal/mol	19.59%	5.77	-36.50 kcal/mol	-36.50 kcal/mol
40	>cel-mir-72 MI0000043	-43.59 kcal/mol	16.92%	4.07	-42.50 kcal/mol	-42.50 kcal/mol
41	>cel-mir-73 MI0000044	-36.16 kcal/mol	13.05%	6.62	-33.80 kcal/mol	-34.90 kcal/mol
42	>cel-mir-74 MI0000045	-38.57 kcal/mol	24.51%	4.22	-37.70 kcal/mol	-37.70 kcal/mol
43	>cel-mir-75 MI0000046	-34.87 kcal/mol	7.86%	5.79	-33.30 kcal/mol	-33.30 kcal/mol

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44	>cel-mir-77 MI0000048	-35.74 kcal/mol	6.97%	9.80	-32.10 kcal/mol	-34.10 kcal/mol
45	>cel-mir-79 MI0000050	-33.50 kcal/mol	19.60%	4.26	-31.10 kcal/mol	-32.50 kcal/mol
46	>cel-mir-80 MI0000051	-29.47 kcal/mol	6.64%	12.39	-27.80 kcal/mol	-27.80 kcal/mol
47	>cel-mir-81 MI0000052	-42.01 kcal/mol	5.32%	7.80	-39.90 kcal/mol	-40.20 kcal/mol
48	>cel-mir-82 MI0000053	-34.58 kcal/mol	27.98%	2.55	-33.80 kcal/mol	-33.80 kcal/mol
49	>cel-mir-83 MI0000054	-28.16 kcal/mol	10.94%	11.86	-22.50 kcal/mol	-26.80 kcal/mol
50	>cel-mir-84 MI0000055	-24.11 kcal/mol	14.01%	2.71	-22.90 kcal/mol	-22.90 kcal/mol
51	>cel-mir-85 MI0000056	-40.70 kcal/mol	7.44%	6.18	-38.70 kcal/mol	-39.10 kcal/mol
52	>cel-mir-86 MI0000057	-43.84 kcal/mol	15.83%	3.50	-40.30 kcal/mol	-42.70 kcal/mol
53	>cel-mir-87 MI0000058	-46.54 kcal/mol	1.63%	5.79	-44.90 kcal/mol	-44.00 kcal/mol
54	>cel-mir-90 MI0000059	-44.62 kcal/mol	10.02%	4.46	-43.20 kcal/mol	-43.20 kcal/mol
55	>cel-mir-124 MI0000302	-39.59 kcal/mol	14.58%	6.87	-36.40 kcal/mol	-38.40 kcal/mol
56	>cel-mir-228 MI0000303	-44.86 kcal/mol	15.23%	4.06	-41.90 kcal/mol	-43.70 kcal/mol
57	>cel-mir-229 MI0000304	-55.67 kcal/mol	1.54%	17.64	-50.90 kcal/mol	-53.10 kcal/mol
58	>cel-mir-230 MI0000305	-39.42 kcal/mol	5.19%	6.85	-37.50 kcal/mol	-37.60 kcal/mol
59	>cel-mir-231 MI0000306	-33.40 kcal/mol	5.40%	8.80	-31.60 kcal/mol	-31.60 kcal/mol
60	>cel-mir-232 MI0000307	-37.20 kcal/mol	16.90%	5.00	-35.80 kcal/mol	-36.10 kcal/mol
61	>cel-mir-233 MI0000308	-38.92 kcal/mol	8.53%	4.73	-37.40 kcal/mol	-37.40 kcal/mol
62	>cel-mir-234 MI0000309	-27.04 kcal/mol	8.26%	4.88	-25.50 kcal/mol	-25.50 kcal/mol
63	>cel-mir-235 MI0000310	-31.29 kcal/mol	1.76%	13.20	-27.50 kcal/mol	-28.80 kcal/mol
64	>cel-mir-236 MI0000311	-38.76 kcal/mol	3.55%	7.62	-36.70 kcal/mol	-36.70 kcal/mol
65	>cel-mir-237 MI0000312	-37.15 kcal/mol	3.57%	6.10	-31.50 kcal/mol	-35.10 kcal/mol
66	>cel-mir-238 MI0000313	-39.38 kcal/mol	10.60%	6.22	-37.70 kcal/mol	-38.00 kcal/mol
67	>cel-mir-239a MI0000314	-33.64 kcal/mol	13.28%	4.78	-32.40 kcal/mol	-32.40 kcal/mol
68	>cel-mir-239b MI0000315	-38.52 kcal/mol	31.16%	2.88	-37.80 kcal/mol	-37.80 kcal/mol
69	>cel-mir-240 MI0000316	-22.86 kcal/mol	5.74%	7.14	-20.90 kcal/mol	-21.10 kcal/mol
70	>cel-mir-241 MI0000317	-34.89 kcal/mol	2.88%	6.77	-32.20 kcal/mol	-32.70 kcal/mol
71	>cel-mir-244 MI0000320	-36.99 kcal/mol	20.12%	4.55	-36.00 kcal/mol	-36.00 kcal/mol
72	>cel-mir-245 MI0000321	-31.62 kcal/mol	16.36%	8.64	-27.00 kcal/mol	-30.50 kcal/mol
73	>cel-mir-246 MI0000322	-24.77 kcal/mol	12.66%	6.57	-23.50 kcal/mol	-23.50 kcal/mol
74	>cel-mir-247 MI0000323	-37.58 kcal/mol	4.76%	8.19	-35.70 kcal/mol	-35.70 kcal/mol
75	>cel-mir-250 MI0000326	-39.30 kcal/mol	14.37%	2.84	-38.50 kcal/mol	-38.10 kcal/mol
76	>cel-mir-253 MI0000329	-47.25 kcal/mol	5.85%	5.22	-45.30 kcal/mol	-45.50 kcal/mol
77	>cel-mir-255 MI0000331	-28.55 kcal/mol	9.54%	10.17	-24.10 kcal/mol	-27.10 kcal/mol
78	>cel-mir-259 MI0000336	-36.67 kcal/mol	17.72%	5.05	-35.60 kcal/mol	-35.60 kcal/mol
79	>cel-mir-355 MI0000754	-37.24 kcal/mol	2.26%	9.21	-34.10 kcal/mol	-34.90 kcal/mol

80	>cel-mir-356b MI0019158	-20.09 kcal/mol	6.45%	6.52	-15.30 kcal/mol	-18.40 kcal/mol
81	>cel-mir-358 MI0000757	-36.09 kcal/mol	1.76%	9.90	-33.60 kcal/mol	-33.60 kcal/mol
82	>cel-mir-392 MI0000819	-38.44 kcal/mol	35.39%	3.11	-37.80 kcal/mol	-37.80 kcal/mol
83	>cel-mir-784 MI0005184	-28.76 kcal/mol	9.34%	4.10	-24.50 kcal/mol	-27.30 kcal/mol
84	>cel-mir-786 MI0005186	-36.92 kcal/mol	7.28%	6.03	-35.30 kcal/mol	-35.30 kcal/mol
85	>cel-mir-787 MI0005187	-39.99 kcal/mol	32.58%	3.58	-39.30 kcal/mol	-39.30 kcal/mol
86	>cel-mir-788 MI0005188	-33.38 kcal/mol	33.34%	1.90	-32.70 kcal/mol	-32.70 kcal/mol
87	>cel-mir-789-2 MI0005190	-64.03 kcal/mol	7.10%	5.04	-60.50 kcal/mol	-62.40 kcal/mol
88	>cel-mir-790 MI0005191	-34.37 kcal/mol	20.68%	2.47	-33.30 kcal/mol	-33.40 kcal/mol
89	>cel-mir-791 MI0005192	-33.49 kcal/mol	20.02%	4.20	-32.50 kcal/mol	-32.50 kcal/mol
90	>cel-mir-794 MI0005195	-27.49 kcal/mol	27.76%	2.51	-26.70 kcal/mol	-26.70 kcal/mol
91	>cel-mir-795 MI0005196	-34.45 kcal/mol	15.54%	4.99	-33.30 kcal/mol	-33.30 kcal/mol
92	>cel-mir-797 MI0005198	-28.50 kcal/mol	2.81%	11.22	-26.10 kcal/mol	-26.30 kcal/mol
93	>cel-mir-800 MI0005201	-54.97 kcal/mol	55.06%	0.89	-54.60 kcal/mol	-54.60 kcal/mol
94	>cel-mir-1820 MI0007982	-40.02 kcal/mol	22.60%	5.32	-39.10 kcal/mol	-39.10 kcal/mol
95	>cel-mir-1821 MI0007983	-32.09 kcal/mol	2.06%	11.81	-27.20 kcal/mol	-29.70 kcal/mol
96	>cel-mir-1822 MI0007984	-32.27 kcal/mol	17.50%	4.79	-31.20 kcal/mol	-31.20 kcal/mol
97	>cel-mir-1823 MI0007985	-26.43 kcal/mol	11.52%	5.28	-22.70 kcal/mol	-25.10 kcal/mol
98	>cel-mir-1829b MI0008198	-21.74 kcal/mol	67.49%	1.00	-21.50 kcal/mol	-21.50 kcal/mol
99	>cel-mir-1829c MI0008199	-20.35 kcal/mol	56.50%	1.38	-20.00 kcal/mol	-20.00 kcal/mol
100	>cel-mir-1830 MI0008200	-35.96 kcal/mol	34.49%	3.70	-35.30 kcal/mol	-35.30 kcal/mol
101	>cel-mir-1832a MI0008202	-36.86 kcal/mol	11.07%	3.56	-35.50 kcal/mol	-35.50 kcal/mol
102	>cel-mir-1832b MI0010967	-44.60 kcal/mol	32.19%	2.79	-43.60 kcal/mol	-43.90 kcal/mol
103	>cel-mir-2208a MI0010956	-24.02 kcal/mol	36.44%	1.69	-23.40 kcal/mol	-23.40 kcal/mol
104	>cel-mir-2208b MI0010957	-27.27 kcal/mol	33.97%	1.94	-26.60 kcal/mol	-26.60 kcal/mol
105	>cel-mir-2221 MI0010974	-43.52 kcal/mol	11.81%	7.16	-42.20 kcal/mol	-42.20 kcal/mol
106	>cel-mir-4805 MI0017535	-49.11 kcal/mol	16.52%	8.53	-48.00 kcal/moli	-48.00 kcal/mol
107	>cel-mir-4813 MI0017543	-39.96 kcal/mol	47.56%	1.24	-39.50 kcal/mol	-39.50 kcal/mol
108	>cel-mir-4814 MI0017544	-66.59 kcal/mol	38.34%	2.76	-66.00 kcal/mol	-66.00 kcal/mol
109	>cel-mir-4816 MI0017546	-24.54 kcal/mol	35.29%	2.53	-23.90 kcal/mol	-23.90 kcal/mol
110	>cel-mir-5545 MI0019066	-64.97 kcal/mol	46.98%	2.35	-64.50 kcal/mol	-64.50 kcal/mol
111	>cel-mir-5592-1 MI0019153	-40.09 kcal/mol	27.56%	2.99	-39.30 kcal/mol	-39.30 kcal/mol

112	>cel-mir-5592-2 MI0019154	-41.50 kcal/mol	32.17%	3.28	-40.80 kcal/mol	-40.80 kcal/mol
113	>cel-mir-5594 MI0019157	-26.98 kcal/mol	14.80%	3.10	-25.80 kcal/mol	-25.80 kcal/mol

Table 1: This table explains that miRBase precursors of *C. elegans*. These sequences pass from RNA fold web server for thermodynamics analysis with minimum free energy

Results and Discussion

Here we have analyzed optimal minimum free energy (MFE) of miRBase precursors of *C.elegans*. Present study is exclusively based on in silico. Firstly we retrives precursor sequences from miRBase and then this sequence is submitted in RNA fold web server for minimum free energy values.

The most common software programs, employed to predict the secondary RNA structures by MFE algorithms, make use of the so-called nearest-neighbor energy model. This model uses free energy rules based on empirical thermodynamic parameters and computes the overall stability of an RNA structure by adding independent contributions of local free energy interactions due to adjacent base pairs and loop regions. In sequences with homogeneous nucleotide arrangements and compositions, the additive and independent nature of the local free energy contributions suggests a linear relationship between computed MFE and sequence length. Normalization by length, obtained by dividing MFE by the number of nucleotides, was introduced to exploit this linear relationship to directly compare the minimum free energies of RNAs of various lengths [14,15].

In Table 1 we have predicted Free energy of thermodynamics, Frequency of MFE structure, Ensemble diversity, Minimum free energy of centeriod secondary structure. The minimum free energy (MFE) of ribonucleic acids (RNAs) increases at an apparent linear rate with sequence length. Simple indices, obtained by dividing the MFE by the number of nucleotides, have been used for a direct comparison of the folding stability of RNAs of various sizes.

Conclusion

In this study entitled: Analysis of *C. elegans* via bioinformatics approaches basis on their precursors statistics values, analyze the statistical values of miRNA and their precursors. For computational analysis of miRNA we always predict the MFE values from precursor sequences which is already experimentally identified and this precursor sequences retrieves from miRBase, for miRNA targeted genes and other analysis also. This table explains all precursors and miRNAs mainly important values, these values always used in noncoding RNA analysis via the system biology. Our computational findings may be useful for researchers.

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