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A Computational analysis on Lectin and Histone H1 protein of different pulse species as well as comparative study with rice for balanced diet

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Abstract:
The issue of balanced nutrition is of great concern to human. Meat and fish are the best sources of protein. The affordability of these resources for people in developing countries is less. Thus, there is an increasing interest in pulses and its derivates as an alternative to fish and meat. Lectin and histone H1 are the most common proteins in various pulses and our interest is in identifying the dominant essential amino acids in them for use as supplements. However, actin and lectin are common among *Oryza Sativa* and *cicer arietinum*. We describe the amount of lectin and histone H1 in *cicer arietinum*, *Lens culinaris* and *Pisum sativum* in a comparative manner. *cicer arietinum* was found to contain more essential amino acids than *Lens culinaris* and *Pisum sativum*. The secondary structures of lectin and histone H1 protein were analyzed to gain functional inferences in these species. The comparative study shows the relatively poor presence of the amino acid methionine in most pulses. However, *Oryza Sativa* was found to contain sufficient methionine. The study shows that pulses (especially *cicer arietinum*) were a suitable alternative source to meat and fish for Lectin and Histone H1 balance. Hence, pulses could be suggested with rice for balanced protein diet.

Keywords: Lectin, actin, histone H1 protein, balance diet, human, sequence analysis.

Background:
Proteins are the most abundant biological macromolecules occurring in a cell and all parts of cells. They are the chief actors, said to be carrying out the duties specified by the information encoded in genes **[1, 2]**. Needed by the human body importantly for growth and maintenance, there are different sources of proteins. Among them, pulses are important cereals due to their high protein and essential amino acid content **[3].** Pulses are used as food and animal feed and provide protein, complex carbohydrates and several vitamins and minerals. Like other plant based foods, they contain cholesterol and little fat or sodium. They are 20-25% protein by weight, which is double the protein content of wheat and three times that of rice. Although pulses are generally high in protein content and the digestibility of that protein is also high, they often are relatively poor in the essential amino acid methionine **[3, 4]**. In South ***Asia*** especially in Indian subcontinent, people are habituated to take rice and pulse as their daily meal **[4, 5].**Rice is the staple food of over half the world's population. It is the predominant dietary energy source for the countries of Asia and the pacific region, 9 countries of North and South America and 8 countries of Africa. Rice provides 20% of the world's dietary energy supply. It is a good source of protein and carbohydrates that are required for energy **[5].** Essential amino acids are those that are mandatory for good health but cannot be synthesized by the body and so must be supplemented through the diet. There are ten amino acids generally considered essential for humans **[6, 7]**. However, rice and pulse are good sources of these essential amino acids **[7].** If

the types of pulses or rice which provide more essential amino acids could be found, it will be easy to fulfill our daily nutrients requirements **[8].** A comparative study was performed among *cicer arietinum*, *Lens culinaris* and *Pisum sativum* to understand which supplies more essential amino acids. In order to analyze essential amino acid compositions, we considered two common proteins e.g. - Lectin and Histone H1 from *cicer arietinum*, *Pisum sativum*, and *Lens culinaris*. Computational analysis showed that Lectin and Histone H1 are relatively poor in the essential amino acid methionine. The main purpose of our study was to observe the essential amino acids we can identify from pulses and if it is lacking, to provide sufficient essential amino acids that can fulfill our daily essential amino acid requirements. Apart from this, another study was done to see how many essential amino acids are obtained from *Oryza sativa* Lectin protein or if it provided sufficient amino acids especially Methionine. In order to maintain a balanced diet which will provide more essential amino acids **[9],** the amino acid compositions and their secondary structures were compared **[10].**

Methodology:

Sequence Retrieval

The amino acid sequence of lectin, histone H1 and actin from 3 pulse species including *Lens culinaris*, *Cicer arietinum* and *Pisum sativum* and a rice species *Oryza sativa* indica were retrieved from the national center for biotechnology information (NCBI) resource **[11]** with the following accession numbers AAS55887.1, AA062538.2, AAA33675.1 for lectin protein of *Lens culinaris*, *Cicer arietinum* and *Pisum sativum* respectively and AAK29456.1, CAA07233.1, AAA50303.1 for histone H1 protein of *Lens culinaris*, *Cicer arietinum* and *Pisum sativum* respectively. The sequence of *Cicer arietinum* and *Oryza sativa* indica have accession number as ACD37723.1, CAA33874.1 for actin and AA062538.2, AAD27889.1 for lectin successively.

Analysis of amino acid composition

To evaluate the amino acid composition and physiochemical properties, ProtParam was used. It is available on ExPASY **[12].**

Multiple sequence alignment

The amino acid sequence of lectin and histone H1 from different pulse species were aligned along with each other using Clustalw2 **[13].**

Secondary structure analysis

GOR was used to compare and analyse the secondary structure of amino acid sequences. **[14].**

Results:

Sequence analysis from gene bank showed that the protein lectin contains 268 amino acids in *cicer arietinum* whereas it contains 229 amino acids in *Lens culinaris*, and 265 amino acids in *Pisum sativum*. According to the ProtParam result, lectin protein of *Lens culinaris* contains 48.9% of essential amino acids, *cicer arietinum* contains 52%, and *Pisum sativum*, 52.1% essential amino acids **(Figure 1B)** respectively**.** In case of histone H1 protein **(Figure 3)** *Cicer arietinum* comprised of 188 amino acids, *Lens culinaris* contains 293 amino acids and *Pisum sativum* contains 185 amino acids. Protparam indicated that the percentage of essential amino acids for histone H1 protein was 40.9% in *Lens culinaris*, 55.3% in *cicer arietinum* and 55.2% in *Pisum sativum* **(Figure 1A).**

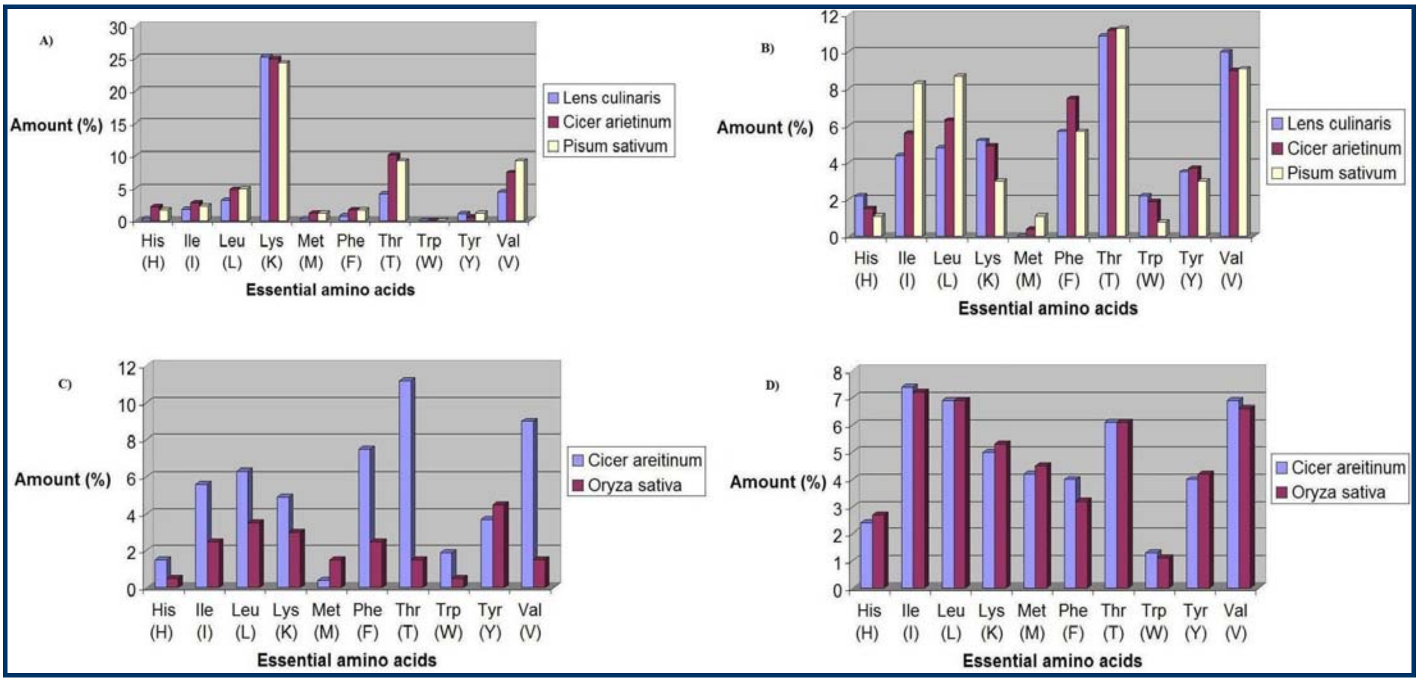

Figure 1: ProtParam result for amino acid composition of (A) histone H1 protein of *Lens culinaris, cicer arietinum* and *Pisum sativum* (B) lectin protein of *Lens culinaris, cicer arietinum* and *Pisum sativum* (C) lectin protein of *cicer arietinum* and *Oryza sativa* (D) actin protein of *cicer arietinum* and *Oryza sativa*.

The length of amino acid sequences and percentage of essential amino acids are found to be similar between *Pisum sativum* and *cicer arietinum* than *Lens culinaris*. Analysis of lectin and histone H1 protein among these three species of pulses using Clustal W2 showed the changes in amino acid sequences and their multiple sequence alignment (shown respectively in **Figure 2 and 3**).

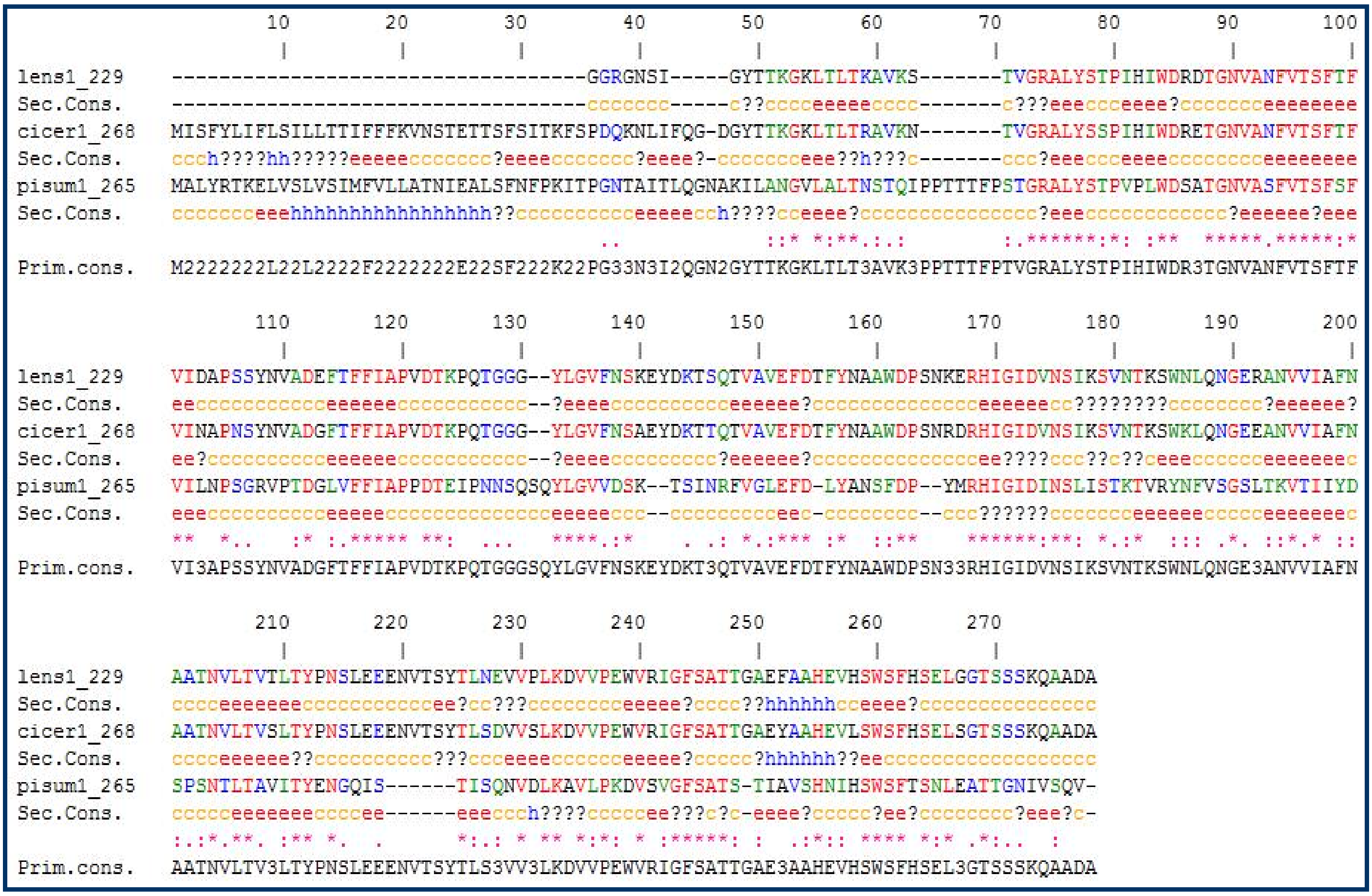

Figure 2: GOR result of lectin protein for *Lens culinaris*, *cicer arietinum* and *Pisum sativum.*

Secondary structure analysis was also done with GOR to compare secondary structural changes in these significant positions of amino acids changes (Also in **Figure 2 & 3**). In count of total food value, whole, dried, boiled *cicer arietinum* contains 27.4gm of carbohydrates, 9.5gm of protein, 2.5gm of lipid, per 100gm, whereas *Pisum sativum* contains 25.2gm carbohydrate, 9.2gm Protein, 1gm fatty acid per 100gm dried pea. 100gm of dried, boiled *Lens culinaris* contains 9gm protein, 20gm carbohydrates and 0.4gm of fatty acid. *cicer arietinum* and *Oryza sativa* indica were compared in terms of lectin and actin that were common in both. *cicer arietinum* contains 268 amino acids and *Oryza sativa* indica contains 200 amino acids for lectin. Both contain 377 amino acids for actin protein. Comparative analysis of essential amino acid composition with ProtParam indicated that actin of *cicer arietinum* contains 48.2% of essential amino acids, while that of *Oryza sativa* indica contains 47.8% **(Figure 1D).** Further, lectin protein contains 52% essential amino acid in *cicer arietinum* and 21.5% in *Oryza sativa* indica **(Figure 1C).** Computational analysis showed that Lectin and Histone H1 were relatively poor in the essential amino acid such as methionine, however, *Oryza sativa* provided sufficient amino acids especially methionine. Analysis of secondary structure, changes in amino acid sequences and multiple sequence alignment with GOR was done for actin and lectin protein of *cicer arietinum* and *Oryza sativa* indica.

Discussion:

With reference to the analysis of pulse proteins, lectin and histone H1 are good sources of essential amino acids. ProtParam results from the study **(Figure 1A & 1B)** show the composition of essential amino acids of lectin and histone H1 among *cicer arietinum, Lens culinaris, Pisum sativum*. It also shows that *Lens culinaris* provided less number of essential amino acids than *cicer arietinum* and *Pisum sativum* **(Figure 1A & 1B).** It also showed that the other two types of pulses e.g.; *cicer arietinum* and *Pisum sativum* provided more essential amino acids than *Lens culinaris* **(Figure 1A & 1B)**. One of the main aims of our experiment was to observe the amino acids composition among three types of pulses. Accordingly, ProtParam results indicate that *Lens culinaris* did not provide many essential amino acids as compared to *cicer arietinum* and *Pisum sativum* **(Figure 1A & 1B).** It can thus be said that *cicer arietinum* and *Pisum sativum* is better than Lens culinaris as they provide more essential amino acids **(Figure 1A & 1B).**

A comparison between *Pisum sativum* and *cicer arietinum* showed that both were good sources of essential amino acids. In count of total food value, *cicer arietinum* contains more proteins per 100 gm (discussed in results) **[15].** Similarly, lectin and histone H1 proteins of the three pulses were compared by clustalW2 software to study the similarities among them. This showed that there were more similarities between *Pisum* *sativum* and *cicer arietinum*. The secondary structures of two proteins were also analysed by GOR software which helped predict the functions of proteins **(Figure 2 & 3)**.

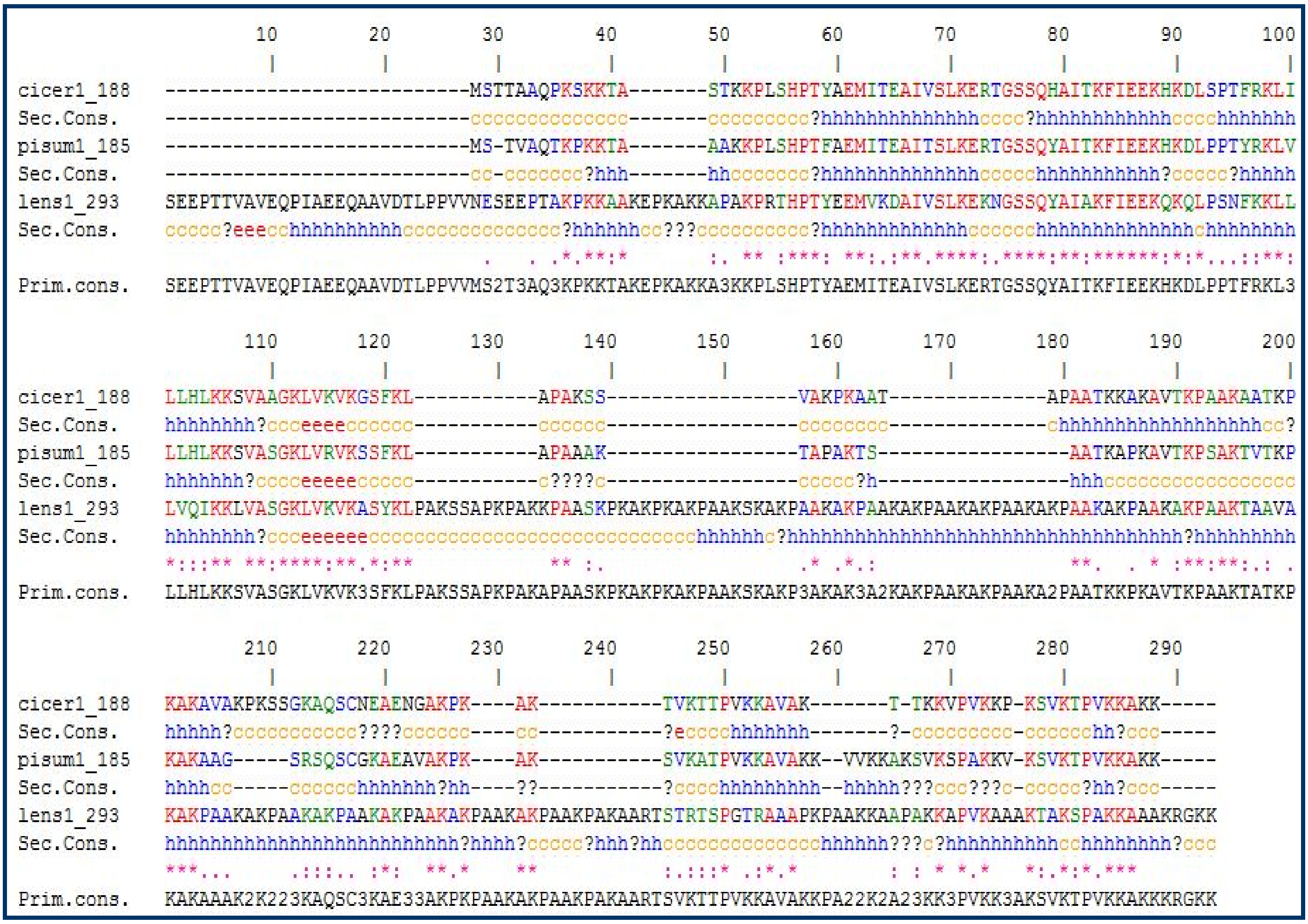

Figure 3: GOR result of histone H1 protein for *Lens culinaris*, *cicer arietinum* and *Pisum sativum*

Our ProtParam results indicate that *cicer arietinum* provides more essential amino acids than *Lens culinaris* and *Pisum sativum*, but it does not provide all the essential amino acids at high concentration such as methionine for our body. In order to maintain a balanced diet providing us with all the essential amino acids that would be better for us. For this reason, we analyzed rice with pulses. Actin and lectin protein are common proteins between *cicer arietinum* and *Oryza sativa* (indica). ProtParam results showed that actin and lectin proteins of *Oryza sativa* (indica) provides a good numbers of essential amino acids which can be the supplement to pulse proteins **(Figure 1C & 1D).**Histone H1 of *cicer arietinum* provides 1.1% methionine and lectin of *cicer arietinum* provides 0.4% methionine whereas actin protein of *Oryza sativa* (indica) provides 4.5% of methionine and lectin protein of *Oryza sativa* (indica) provides 1.5% 0f methionine **(Figure 1C & 1D). O**ther essential amino acids that cannot be found properly from pulse proteins could be supplemented by rice proteins. As essential amino acids are needed considerably in our body, we can make a balanced diet which will provide all the essential amino acids better **[16].** For this purpose, our computational study revealed that *cicer arietinum* and *Oryza sativa* (indica) could be a good combination in case of essential amino acids.

Conclusion:

The types of amino-acids in lectin and histone H1 protein were found to be almost similar. *cicer arietinum* contains more essential amino acid than *Lens culinaris* and *Pisum sativum*. Hence, lectin and histone proteins are suggested alternative to meat and fish for balanced diet with rice.

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