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RESEARCH ARTICLE

Exploring *cajanus cajan* pod protein concentrates: an eco-friendly supplement alternative and vegetable waste management solution

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Abstract

Cajanus cajan, commonly known as pigeon pea, is a legume with multiple applications in agriculture and nutrition. The present study highlights the crucial significance of utilizing *Cajanus cajan* pod protein concentrates (PPC) as an eco-friendly, renewable, and cost-effective solution for supplementing protein-deficient conditions in rural areas. Specifically, in regions facing challenges like Protein-Energy Malnutrition (PEM), including Marasmus and Kwashiorkor, these PPCs can offer a promising alternative to address nutritional deficiencies and promote sustainable dietary practices. The study also emphasizes the crucial role of *Cajanus cajan* in vegetable waste management, showcasing its potential to reduce waste and promote sustainability in the food industry. In-depth acute toxicity studies using Wistar rat as animal model have been conducted to ensure the safety of these protein concentrates as an alternative supplement. Biochemical parameter assessments provide valuable insights and potential health benefits of these pod protein concentrates. Moreover, the research investigates the protein efficiency ratio (PER) of *Cajanus cajan* pod protein concentrates, which provides information in their effectiveness in supporting growth and development in animal subjects. The PER results shed light on the efficiency and quality of protein utilization, making it an essential factor for evaluating their suitability as a supplement alternative.

Overall, this comprehensive exploration establishes *Cajanus cajan* pod protein concentrates as a promising solution for sustainable supplement sourcing, vegetable waste management, and advancing eco-conscious practices in the food industry."

Keywords: Acute toxicity, *Cajanus cajan*, waste pods, protein concentrate, biochemical tests, PER-protein efficiency ratio, Waste management, Protein supplements.

Introduction

Cajanus cajan, commonly known as pigeon pea, is a legume with multifaceted implications for agriculture and nutrition. This remarkable leguminous plant has a rich history of cultivation dating back at least 3000 years. Its probable center of origin is Asia, from where it spread to East Africa and eventually made its way to the American continent through the slave trade. (Sharma *et al*., 2011). This research explores the vital significance of utilizing *Cajanus cajan* pod protein concentrates (PPC) as an eco-friendly, renewable, and cost-effective solution to combat protein deficiency in rural areas. Particularly in regions grappling with Protein-Energy Malnutrition (PEM), including Marasmus and Kwashiorkor, PPCs can offer a promising alternative to rectify nutritional deficits and promote sustainable dietary practices.

Safety is of paramount concern, and thus, in-depth acute toxicity studies employing Wistar rats as an animal model have been meticulously conducted to ensure the harmlessness of these protein concentrates as a supplement. Biochemical parameter assessments provide valuable insights into the potential health benefits of these pod protein concentrates.

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Additionally, the current investigation also studies the protein efficiency ratio (PER) of *Cajanus cajan* pod protein concentrates, shedding light on their effectiveness in promoting growth and development in animal subjects. The PER results are instrumental in evaluating the quality and efficiency of protein utilization, making them an essential factor in assessing their suitability as a supplement alternative.

Materials And Methods

Cajanus cajan pods were collected from Vile Parle vegetable market, Vile Parle West, Mumbai and processed into pod protein concentrate (PPC) following method by Fellows (1987).

Acute toxicity tests followed OECD 425 (2022), while protein deficiency tests adhered to Sadasivam (2008). This study had Institutional Animal Ethics Committee approval (Reg. no.- CPCSEA/IAEC/P-72/2022). Male rats were randomly split into two groups: group I (Control) with a normal diet and group II with PPC of *Cajanus cajan* alongside a normal diet for 28 days. Food consumption and body weights were recorded weekly. The study involved feeding Wistar rats with PPC-containing diets, monitoring growth (body weight), feed intake, and protein utilization.

Protein Efficiency Ratio (PER), a key measure of protein quality, was determined by comparing weight gain to protein intake. Furthermore, Feed Efficiency Ratio (FER), indicating nutrient utilization efficiency, was calculated by relating weight gain to feed intake. Simultaneously, blood serum samples were analyzed for biochemical parameters to assess the potential nutritional support of PPC from *Cajanus cajan*.

Observations

Since the *p-value* is less than 0.05, we reject the null hypothesis (H_0). This means there is a statistically significant difference in the mean weight gain between the control group and the test group which was supplemented by the protein concentrates extracted and prepared from the empty pods of Cajanus cajan.

In conclusion, the protein supplement (test group) has a significant effect on the weight gain compared to the control group, as evidenced by the very small p-value and the high F-value

Results and Summary

Acute oral toxicity study

The treated animals that received the largest oral dose of PPC of *Cajanus cajan* i.e., 2000 mg/kg, lived through the entire trial and showed no symptoms up to 14 days following dosing. Table 1 shows their PER and FER readings.

Biochemical parameters

For the serum biochemistry profile analysis, blood samples without anticoagulants were used. Table 2 shows the mean Total protein, Albumin, ALT (Alanine Aminotransferase), AST (Aspartate Aminotransferase), ALP (Alkaline Phosphatase), and Creatinine levels.

Table 1: PER and FER results of *Cajanus cajan* (PPC)

Parameters	*Control*	*Cajanus cajan (PPC)*
Initial weight (g)	100.30 ± 15.28	96.39 ± 9.91
Final weight (g)	224.3 ± 23.01	231.908 ±19.70
Weight gain (g)	123	135.5
FER	0.84	0.96
PER	2.19	2.41

mean ±SD (n=5). Average weight gain ± SD.
No significant variation was observed in between control and PPC of *Cajanus cajan* which is ($p < 0.05$) .

Table 2. Biochemical parameters of *Cajanus cajan* (PPC)

Parameters	*Control*	*Cajanus cajan (PPC)*
Total protein g/dl	6.1 0	6.3
Albumin g/dl	2.9	2.8
ALT IU/L	81	85.6
AST IU/L	62.6	64.6
ALP IU/L	45.3	44.1
Creatinine mg/dl	0.6	0.7

(n = 3)

Discussion

The health of the liver and the diagnosis of diseases often involve monitoring the activity of serum AST, ALP, and ALT, which are sensitive indicators of liver toxicity (Cui *et al.,* 2011). These enzymes are released into the bloodstream when organs are injured for any reason.

Creatinine, a chemical waste product excreted by the kidneys, is carried through the bloodstream. Elevated creatinine levels suggest inadequate kidney filtration (Hasan *et al.,* 2018). Reference ranges for AST, ALT, ALP, total protein, creatinine, and albumin are typically set at 50-150 IU/L, 52-224 IU/L, 30-130 IU/L, 4.5-8.4 mg/dl, 0.4-1.4 mg/dl, and 2.9-5.9 g/dl, respectively (Sharp and Villano, 2013).

In a study from 2007, the quality of protein in *Hibiscus Sabdariffa* L. seeds was explored (Halimatul et al., 2007), while in 2022, Mhlomi et al., assessed rats that were fed protein-deficient diets supplemented with *Moringa oleifera leaf meal*.

Conclusion

In conclusion, this study provides invaluable insights into the nutritional and physiological implications of integrating *Cajanus cajan* (PPC) into dietary plans.

Analysis of the Protein Energy Ratio (PER) and Feed Efficiency Ratio (FER) highlights the quality and efficiency

of PPC as a sustainable protein source. The PER values, reflecting weight gain relative to protein intake, strongly support *Cajanus* PPC as a promising protein supplement.

Furthermore, the comprehensive assessment of blood serum biochemical parameters deepens our understanding of PPC's potential physiological effects, emphasizing the need for further exploration into its broader health implications.

Utilizing *Cajanus cajan* for PPC production not only addresses protein deficiencies but also aligns with sustainability goals by repurposing plant components that might otherwise go to waste. By harnessing this readily available and underutilized resource, we can make strides towards more efficient and ecologically responsible nutritional supplement production.

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