iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** X **Month of publication:** October 2018

DOI:

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue X, Oct 2018- Available at www.ijraset.com

Quantitative Analysis of Antioxidants in Five Native Tuber Crops in Kerala

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Abstract: ***Tubers are rich sources of natural phytochemicals. They are enlarged structures used as storage organs, present in some plant species. Several tubers possess a wide range of antioxidants which may contribute to the modern medical field. Hence, a study was planned which included quantitative analysis of phytochemicals which act as antioxidants in five native tuber species in Kerala. It included Amorphophallus paeoniifolus, Maranta arundinacea, Plectranthus rotundifolius, Colocasia esculenta and Dioscorea alata. Here, six antioxidants such as alkaloid, flavonoid, phenol, tannin, saponin and terpenoid were quantitatively examined. In this study, it was found that Amorphophallus paeoniifolus showed high amount of phenol (0.1785mg/100g) and flavonoid (203mg/100g). Both were seemed to be less in Colocasia esculenta (0.0468mg/100g and 0.1785mg/100g respectively). The highest amount of saponin was found in Maranta arundinacea (47.873mg/100g) and it was least in Amorphophallus paeoniifolus (6.61mg/100g). High amount of alkaloid was present in Plectranthus rotundifolius (102.573mg/100g) and was found to be lowest in Colocasia esculenta (15.581mg/100g). This study reveals that A. paeoniifolus, P. rotundifolius, D. alata are potent source of selected antioxidants. Too much tannin is bad for health, so A. paeoniifolus is better option for tannin consumption. These natural compounds play a vital role in plant metabolic activities like growth, reproduction and providing an efficient protection against pathogens and predators. So the above mentioned tubers should be included in our daily diet according to their antioxidant property.***
Keywords: Antioxidant, Flavonoid, Tannin, Saponin, Phenol.

I. INTRODUCTION

The importance of plants is known to us well, the plant kingdom is a treasure house of potential drugs. They are enlarged structures used as storage organs, present in some plant species. They are used for several actions like plant perennation, to provide energy and nutrients for regrowth during the next growing seasons and as a means of asexual reproduction. Some sources define the term 'tuber' as the only structures derived from stems, others use the same for structures derived from stems or roots. Antioxidant is a reducing agent which stabilizes oxidants by donating electrons or protons towards the oxidant. In the past few decades, there has been growing evidence that oxidative stress and specific human diseases can be prevented by including in the diet plant foods that contain large amounts of antioxidants such as vitamins C, E or natural antioxidants such as flavonoids, tannins, coumarins, phenolic and terpenoids (Perumalla & Hettiarachchy, 2011). These compounds play an important role in plant growth and reproduction, providing an efficient protection against pathogens and predators.

II. MATERIALS AND METHODS

The following five native tubers in Kerala were selected for the study.

A. *Amorphophallus paeoniifolus*
B. *Maranta arundinacea*
C. *Plectranthus rotundifolius*
D. *Colocasia esculenta*
E. *Dioscorea alata*

1) *Methodology*

a) *Estimation of flavonoids:* The total flavonoid content (mg/ml) was determined using Aluminium Chloride method (Zshishen *et al.*, 1999 & Zou *et al.*, 2004).
b) *Estimation of phenol:* The total phenolic content of the extracts were determined by Folin – Ciocalteu reagent method (Chun *et al.*, 2003).
c) *Estimation of alkaloids:* The alkaloid content was determined using (Trease & Evans, 2002).

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d) Estimation Of Tannins: Total tannin content was determined by using Folin – Ciocalteu Spectrophotometric method (Trease & Evans, 1992).

e) Estimation Of Terpenoids: Estimation of terpenoid was determined using procedure by Gorai et al., 2014.

f) Estimation Of Saponins: Estimation of total saponin content was determined by the Vanillin- Sulphuric acid colorimetric method (Hiai et al., 1976).

III. RESULTS AND DISCUSSION

The results of the study is discussed below:

A. Estimation Of Total Phenol

The result of estimation of phenolic content of five native tubers was presented in the form of figure1. Among the five selected tubers, the highest phenolic content was observed in *Amorphophallus paeoniifolus* (0.1785mg/100g) followed by *Plectranthus rotundifolius* (0.1723mg/100g), *Maranta arundinacea* (0.145mg/100g), *Dioscorea alata* (0.1431mg/100g), and the least in *Colocasia esculenta* (0.0468mg/100g). A similar study was conducted in Tubers of *Amorphophallus* species by Shete *et al.*, 2015. In his investigation, the tubers of *Amorphophallus commutatus* (Schott) (ACT) and *Amorphophallus paeonifolius* (Dinnst.) (APT) were extracted with three different solvents (ethanol, acetone and water) and screened for total phenolic content and antioxidant activity. Acetone extracts of ACT and APT exhibited the highest phenolic content 17.66±0.44 and 15.90±0.25 mg GAE/g respectively. The wild species of *D.oppositifolia* (774.10 mg of TAE/g extract) showed higher phenolic content than the cultivated variety *Pl. rotundifolius* (244.10 mg of TAE/g extract). The wild species grow in organic environmental conditions, so it could be suggested that growing conditions have a certain effect on the synthesis and accumulation of phenolic compounds. It has been suggested that up to 1.0g polyphenolic compounds (from diet rich fruits or vegetables) ingested daily have remarkable inhibitory effect on mutagenesis and carcinogenesis in human (Rose *et al., 1982).* A study by Samarin *et al*., 2012 revealed the amount of phenolic compounds in *Solanum tuberosum* (522.1-593.3 µg/gdw) was highest in methanol extract.

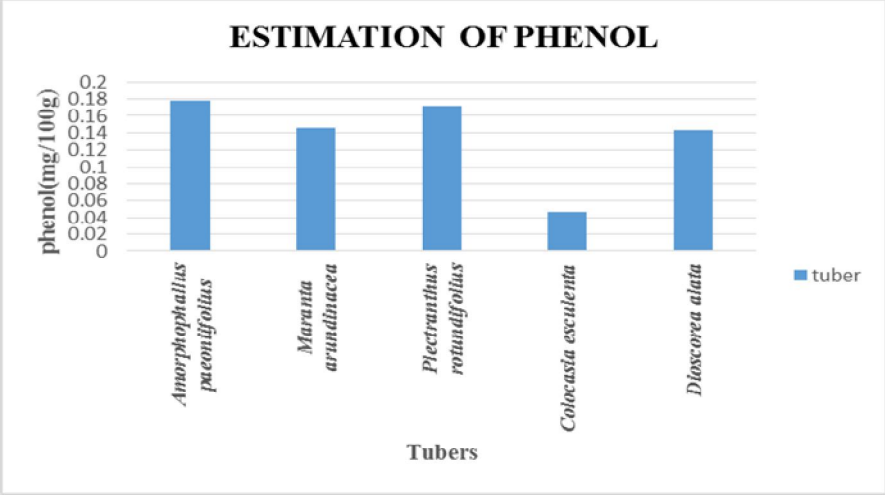

Fig1: Estimation of Phenol

B. Estimation Of Tannin

Results of the tannin content of the study materials were given in figure 2. Tannin is an important antioxidant in plants. In this study high concentration of tannin was found in *Colocasia esculenta* (672.85mg/100g), followed by *Plectranthus rotundifolius* (642.85mg/100g), *Dioscorea alata* (611.42mg/100g), *Maranta arundinacea* (432.85mg/100g) and lowest in *Amorphophallus paeoniifolus* (244.285mg/100g). From this study, it was clear that tannin is rich in *Colocasia esculenta*. A similar study has been conducted by Joy *et al.*, during 2017**.** According to his observation, the tannin content of samples was ranged from 136.82 to 727.69 mg TAE/g. Tannin content was also found to be higher in *D. oppositifolia* (727.69 mg of TAE/g extract) and the lowest value was recorded in boiled tubers of *D. alata* (136.82 mg TAE/g). Tannins were compounded with organic compounds such as proteins, starches and digestive enzymes thus reduce the dietary importance of foods (Serrano *et al.*, 2009). They inhibit protein absorption and reduce iron availability (Bravo L, 1994). So, the minimum level of tannins in the diet is recommended. Ugwu *et al.*, 2017 in their study showed the leaf and stem of *Vernonia amygdalina* were rich in tannins with the root recording the lowest value. This agrees with the general knowledge that secondary metabolites are mostly concentrated in the leaf. Our results fall within the range

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for roots and tubers, from 20.00 mg% for *Dioscorea rotundata* (white yam) to 75.00 % for *Dioscorea alata* (water yam) (Osagie, 1998). The tannin content of the root of *V. amygdalina* was the lowest and therefore appears to be safest for treating diabetic persons, when compared to the leaf and stem. Thus the presence of tannins in *Vernonia amygdalina* lends credence to its antidiabetic properties.

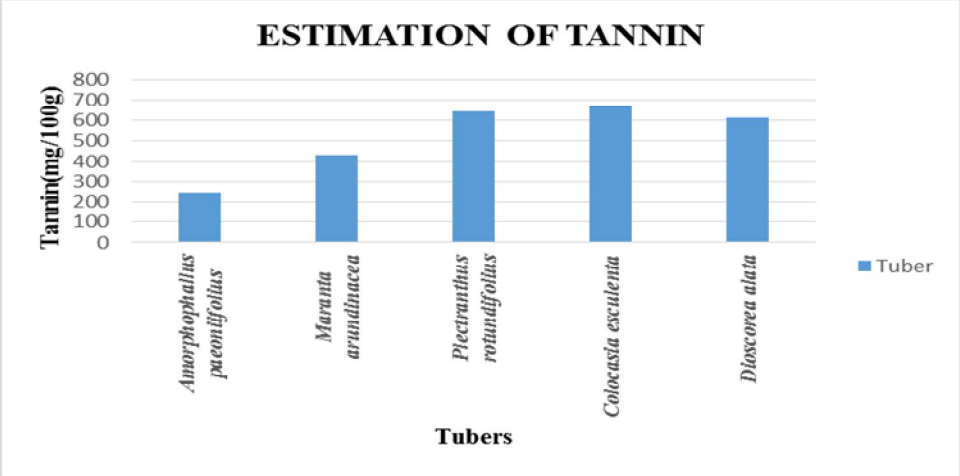

Fig 2: Estimation of Tannin

C. Estimation of flavonoids

Results of the flavonoid content of the selected native tubers were given in figure 3. Flavonoid is an important antioxidant which is present in all plants. They also act as secondary metabolite because they help in metabolic growth. In this study, it was found that high amount of flavonoid was found in *Amorphophallus paeoniifolus* (203mg/100g) followed by *Maranta arundinacea* (179.8mg/100g), *Plectranthus rotundifolius* (178mg/100g), *Colocasia esculenta* (103.5mg/100g) and least in *Dioscorea alata* (47.2mg/100g). A study was conducted by Joy *et al.*, 2017 to evaluate the *in vitro* antioxidant and free radical scavenging capacity of ethanolic extract of three different underutilised *Dioscorea* species (*D.alata, D.pentaphylla* and *D.oppositifolia*) with a common cultivated crop, *Plectranthus rotundifolius*. The highest flavonoid content was found in *D. oppositifolia* (80.06 mg of RUE/g extract) and boiled tubers of *D. alata* have the lowest (50.51 mg of RUE/g extract). Flavonoids serve as health promoting compound as a result of its anion radicals (Atmani *et al.*, 2009). Total flavonoid contents were found to be 39.23±1.205 mg QE/g for *F. benghalensis* seed. The compounds such as flavonoids, which hold hydroxyl groups, are responsible for the radical scavenging activity in the plants. It has been acknowledged that flavonoids show significant antioxidant action on human health and fitness. Nidhi Chowdhary (Chowdhary *et al.*, 2014) reported that *F. benghalensis* leaf extracts contain total flavonoids of 5.11 µg/mg quercetin equivalents. A Study by Yadav *et al.*, 2011 shows that the methanolic extract of *Ficus benghalensis* latex has revealed the presence of total flavonoid content 1.84 mg QE/g. The flavonoid content of *Crocus sativa* in DCM, methanol and water extracts were found to be 1.8 and 9.2 and 11.2mg/g respectively (Mir *et al.*, 2016).

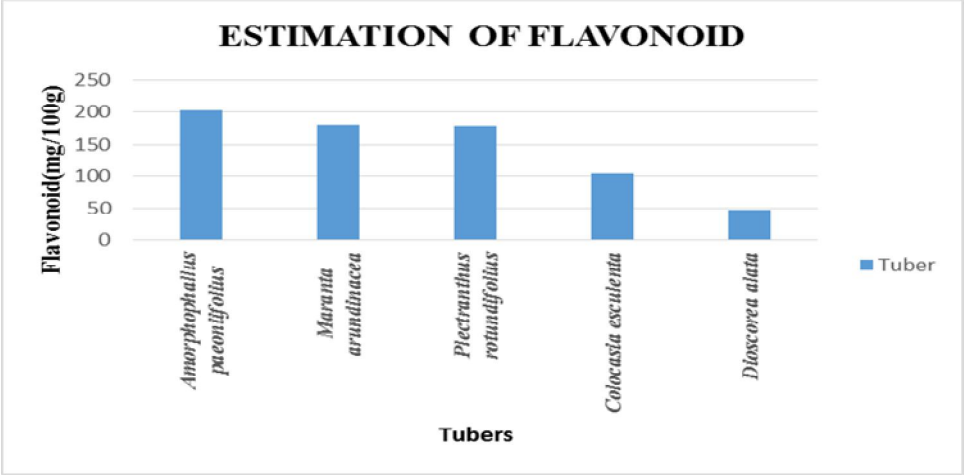

Fig 3: Estimation of Flavonoids

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D. Estimation of Saponins

Results of the saponin content of the study materials were given in figure 4. Saponin is vital antioxidant in all plants. From the result it was clear that high concentration of saponin was found in *Maranta arundinacea* (47.873mg/100g). It was followed by *Dioscorea alata* (44.0421mg/100g), *Colocasia esculenta* (10.736mg/100g), *Plectranthus rotundifolius* (6.694mg/100g), and finally the least in *Amorphophallus paeoniifolus* (6.61mg/100g). A similar study was conducted by Mir *et al.*, 2016 in *Crocos sativa*. The Saponin content of *Crocus sativa* in methanol and water extracts and was found to be (1.2, 3.4mg/g) respectively. A study carried out on the *Anredera cordifolia* plant (Binahong) (Murni Astuti, 2011) determined that fresh and dried samples of Binahong plant shows positive results for saponin compound. The saponin compound including one of phytochemical, screening test of the plant studied showed that leaves, stems, flowers and tubers indicate presence of saponins. Saponin is one of the active constituents (Edeoga *et al*, 2005) and they were known to show medicinal plant activities as well as exhibiting physiological activity (Sofowara, 1993). Saponin has high molecule weight, and in low concentration saponins can used for haemolysis of red blood cell and then for activity of antibacterial function (Harborne, 1973).

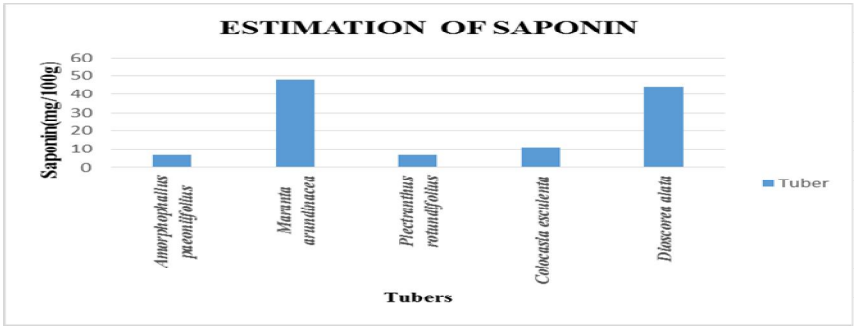

Fig 4: Estimation of Saponins

E. Estimation of alkaloids

Results of the alkaloid content of the samples of five native tubers were given in figure 5. Alkaloids are good source of antioxidants. It was used for many metabolic activities. In this study high amount of alkaloid was present in *Plectranthus rotundifolius* (876.98mg/100g) followed by *Maranta arundinacea* (761.64mg/100g), *Amorphophallus paeoniifolus* (657.53mg/100g), *Colocasia esculenta* (531.5mg/100g) and lowest *Dioscorea alata* (464.93mg/100g). A study on *Actinidia arguta* (Liu *et al.*, 2011) evaluated that the content of alkaloids in roots was the highest, with 1.25mg/g. The alkaloid about 3/4 of the roots, content difference between leaves and fruits were not significant. Stems, about 2/5 of the roots, were the least alkaloid content. Another study in *Crocos sativa* (Mir *et al.*, 2016) found that alkaloid content of *Crocus sativa* flower in methanol and water extracts were found to be (6.4 and 2.4mg/g) respectively. A similar study was conducted by John *et al.*, 2013 in Justicia species. The results showed that the leaf extract of *J. beddomi* showed highest alkaloid content (28.53mg CE) followed by leaf extract of *J. wynaadensis (*26.96 mg CE) and *J. betonica* (26.18 mg CE). The root of *J. wynaadensis* showed least alkaloid content (8.45 mg CE).The higher alkaloid content was revealed in the leaves. The alkaloid content was varied with respect to the parts analysed. Gracelin *et al.*, 2012 in methanolic extract of five Pteris species are selected for alkaloid estimation. The results shows that *Pteris confuse*, *Pteris vittata*, *Pteris argyreae*, *Pteris biaurita*, and *Pteris multiaurita* contain (10.05 ± 0.10, 12.10 ± 0.15, 11.55 ± 0.30, 16.40 ± 0.35, 09.50 ± 0.15mg/g) alkaloid content respectively.

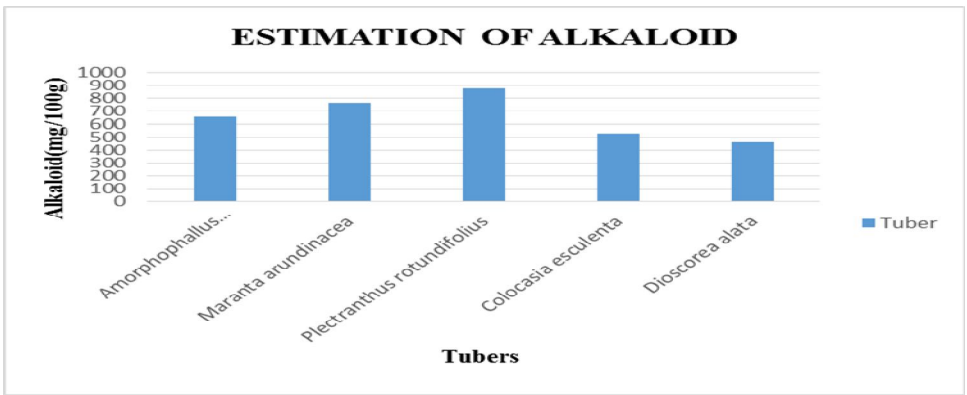

Fig 5: Estimation of Alkaloids

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F. Estimation of Terpenoids

Results of the alkaloid content of selected tubers were given in figure 6. From the result, it was clear that high amount of terpenoid was found in Plectranthus rotundifolius (102.573mg/100g). It was followed by Dioscorea alata (85.574mg/100g), Amorphophallus paeoniifolus (55.911mg/100g), Maranta arundinacea (33.564mg/100g) and the minimum in Colocasia esculenta (15.581mg/100g). Quantification of terpenoids in the aqueous extract of stem of S.oblonga is 96.2 milligram quercetin equivalent per gram (Malar and Chellaram, 2015). Terpenoids represent a diverse class of molecules that are related to therapeutic properties including anti-cancer, anti-parasitic, anti-microbial, anti-allergic, anti-spasmodic, anti-hyperglycemic, anti-inflammatory and immunomodulatory properties (Barre *et al*., 1997, Habtemariam *et al*., 1993, Scortichini *et al*., 1991). Terpenoids are natural secondary metabolite found in plant species which is providing flavour and fragrance. It prevents the development of chronic joint swelling (Agnihotri, 2010).

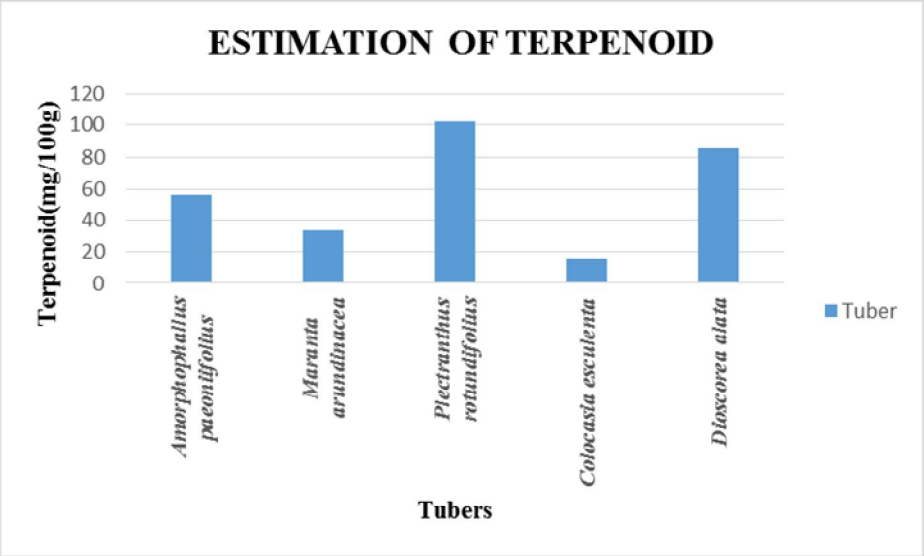

Fig 6: Estimation of terpenoids

IV. SUMMARY AND CONCLUSION

In the study entitled "Quantitative estimation of antioxidants in five native tuber crops in Kerala", antioxidants named alkaloid, flavonoid, phenol, saponin, tannin and terpenoid were quantitatively estimated in five native tubers namely, Amorphophallus paeoniifolus, Maranta arundinacea, Plectranthus rotundifolius, Colocasia esculenta and Dioscorea alata. In this study, it was found that Amorphophallus paeoniifolus showed high amount of phenol (0.1785mg/100g) and flavonoid (203mg/100g). Both were found to be less in Colocasia esculenta (0.0468mg/100g and 0.1785mg/100g respectively). The highest amount of saponin was found in Maranta arundinacea (47.873mg/100g) and it was less in Amorphophallus paeoniifolus (6.61mg/100g). High amount of alkaloid was present in Plectranthus rotundifolius (876.98mg/100g) and was less in Dioscorea alata (464.93mg/100g). The high amount of terpenoid was found in Plectranthus rotundifolius (102.573mg/100g) and was found to be less in Colocasia esculenta (15.581mg/100g). There has been growing evidence that oxidative stress and specific human diseases can be prevented by including in the diet plant foods that contain large amounts of antioxidants such as vitamins C, E or natural antioxidants such as flavonoids, tannins, coumarins, phenolic and terpenoids (Perumalla & Hettiarachchy, 2011). These compounds play an important role in plant growth and reproduction, providing an efficient protection against pathogens and predators. So the above mentioned tubers should be included in our daily diet according to their antioxidant property.

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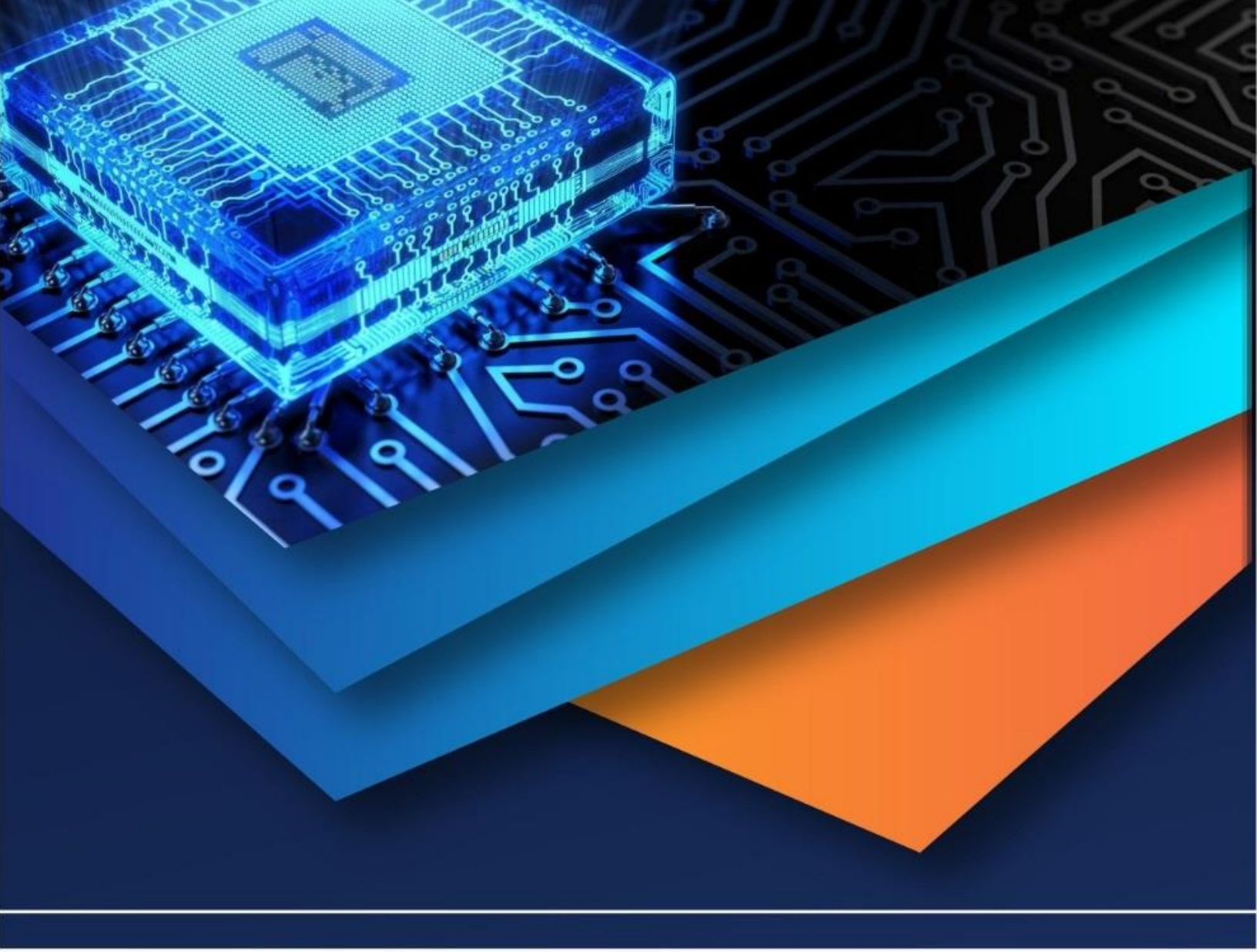

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