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YAZIM KURALLARI

Karatekin Üniversitesi Fen Fakültesi Dergisi yılda iki sayı olarak yayımlanır ve **Biyoloji**, **Fizik**, **Kimya**, **Matematik** ve **İstatistik** alanlarında yapılan özgün ve nitelikli akademik çalışmaları yayımlar. Dergi'de yayımlanmak üzere gönderilen her türlü yazı Editör ön incelemesinden sonra **"Hakem"** inceleme ve değerlendirmesinden geçirilir. Makalenin Dergi'ye sunulması daha önce başka bir yerde yayımlanmadığı ve halen yayımlanması girişiminde bulunulmadığı anlamına gelir.

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Sayfa yapısı olarak **A4 kağıt boyutu kullanılmalı** ve üstten ve soldan 3 cm, alttan ve sağdan 2.5 cm boşluk bırakılmalıdır. Makale metnine sayfa ve satır numarası eklenmelidir. Makale dili **Türkçe** ya da **İngilizce** olmalıdır. Türkçe hazırlanan makaleler Türk Dil Kurumu'nun son yazım kılavuzu dikkate alınarak yazılmalıdır.

Kapak Sayfası: Makale başlığı (makale dilinde), yazarların tam adları (ünvansız olarak) ve çalıştıkları kurumlar ile sorumlu yazarın tüm iletişim bilgilerini (açık adres, e-mektup ve telefon ve belgegeçer numaraları) içermelidir. Makale başlığı, kısa ve açıklayıcı olmalı, ilk harfler büyük olacak şekilde küçük harflerle, 14 punto ve koyu yazılmalıdır. Yazar isimleri küçük, soyadları büyük harflerle (sayfanın ortasında) koyu yazılmalıdır. Yazar kurumları, ilk harfler büyük olacak şekilde küçük harflerle yazılmalıdır.

Özet sayfası: Makale başlığı, özeti (en az 100, en fazla 250 kelime) ve anahtar kelimeler (3-6 adet) makale dilinde verilmelidir. Aynı bilgiler diğer dilde de (makale dili Türkçe ise İngilizce ya da tersi) verilmelidir. Özet, kısaca araştırmanın gerekçesini, amaçlarını, yöntemini, bulguları ve önerileri içermelidir.

Anahtar Kelimeler: Özet sayfasının 1 satır altına her anahtar kelimenin ilk harfi büyük diğerleri küçük harflerle, mümkünse başlıkta kullanılmayan, çalışmayı en iyi biçimde tanımlayacak en az 3 ve en fazla 6 anahtar kelime yazılmalıdır.

Ana metin: Makale ana metni; Giriş; Materyal ve Yöntem; Bulgular; Tartışma ve Sonuç; Kaynaklar bölümlerinden oluşur. Bütün ana bölüm başlıları büyük harflerle ve koyu olacak şekilde, alt başlıklar ise sadece ilk kelimenin ilk harfi büyük ve koyu yazılır. Başlıklar ve paragraf başı 0 cm içeriden başlamalı, paragraflar arası boşluk bırakılmalıdır. Şekil ve tablolar makale içinde uygun yerlere şekil ve tablo numarası verilerek yerleştirilmeli, tablo başlıkları tablonun üst kısmında ve şekil başlıkları şeklin altında verilmelidir. Şekil ve tablo başlıkları mümkün olduğunca kısa ve açıklayıcı olmalıdır. Şekil resim ise yüksek çözünürlükte olmalı, grafik ise anlaşılması kolay olacak şekilde düzenlenmelidir. Tablolarda sadece yatay çizgiler kullanılmalıdır. Makaleye konu canlı tür ya da türlerinin yerel isimleri kullanılıyorsa bunların bilimsel adları metinde ilk geçtikleri yerde belirtilmelidir. Birimler için uluslar arası birimler sistemi kullanılmalı (The International Systems of Units, SI) ve ondalık ifadeler nokta (.) ile belirtilmelidir (örneğin, %45.7 veya 0.221).

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Birimler: Tüm makalelerde SI (System International d'Units) ölçüm birimleri kullanılmalıdır. Ondalık kesir olarak nokta kullanılmalıdır (1,25 yerine 1.25 gibi). Birimlerde "/" kullanılmamalı ve birimler arasında bir boşluk verilmelidir (m/s yerine m s-1, J/s yerine J s-1, kg m/s2 yerine kg m s–2 gibi). Sayı ile sembol arasında bir boşluk bırakılmalıdır (4 kg N ha-1, 3 kg m–1 s–2, 20 N m, 1000 s–1, 100 kPa, 22 °C gibi). Bu kuralın istisnaları düzlemsel açılar için kullanılan derece, dakika ve saniye sembolleridir (°, ' ve "). Bunlar sayıdan hemen sonra konmalıdır (10°, 45', 60" gibi). Litrenin kısaltması "l" olarak belirtilmelidir. Cümle sonunda değillerse sembollerin sonuna nokta konulmamalıdır (kg. değil kg).

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Kaynaklar aşağıdaki örneklerdeki gibi listelenmelidir:

Dergi makaleleri:

Pandey DK, Palni LMS (2005) Germination of Parthenium hysterophorus L. seeds under the influence of light and germination promoting chemicals. Seed Sci Technol 33:485-491

Kitaplar:

Ürgenç S (1988) Genel plantasyon ve ağaçlandırma tekniği. İstanbul Üniversitesi, Orman Fakültesi Yayını, No: 444, İstanbul

Kitapta Bölüm:

Brown B, Aaron M (2001) The politics of nature. In: Smith J (ed) The rise of modern genomics, 3rd edn. Wiley, New York, pp 230-257

Bildiriler:

Demeritt ME (1981) Fifty years of hybrid poplar research in the northeast. In: Proceedings of 27th North-Eastern forest tree improvement Conference. University of Vermont, Burlington, VT, pp 166–183

Tezler:

Kambur S (2009) Rhus coriaria L., Pyracantha coccinea M. Roemer ve Cotoneaster nummularia Fisch.&Mey türlerinin tohum ve çimlenme özelliklerinin belirlenmesi. Artvin Çoruh Üniversitesi Fen Bilimleri Enstitüsü Yüksek Lisans Tezi, Artvin, 40 s

Diğer:

Robbins J, Evans M (2004) Growing media for container production in a greenhouse or nurseries. Part I. Components and mixes. Agriculture and Natural Resources. Division of Agriculture: University of Arkansas, Fayetteville. http://www.uaex.edu/Other_Areas/publications/PDF/FSA-6097.pdf. Accessed 1 Sept 2010

WRITING RULES

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The whole article; It should be written in "Times New Roman" font, 12 points, 1.5 line spacing, and justified, including figures, graphics, photographs and tables.

A4 paper size should be used as the page structure and 3 cm margins should be left from the top and left, and 2.5 cm from the bottom and right. Page and line numbers should be added to the article text. The language of the article should be **Turkish** or **English**. Articles prepared in Turkish should be written by taking into account the latest spelling guide of the Turkish Language Association.

Cover Page: It should contain the title of the article (in the article language), the full names of the authors (without title), the institutions they work with and all the contact information of the responsible author (open address, e-letter and telephone and document valid numbers). The title of the article should be short and descriptive, written in lowercase, 14 pt and bold with the first letters capitalized. Author names should be written in lowercase and surnames in capital letters (in the middle of the page). Author institutions should be written in lower case letters with the first letters in capital letters.

Abstract page: The article title, abstract (minimum 100, maximum 250 words) and keywords (3-6 items) should be given in the language of the article. The same information should be given in the other language (English or vice versa if the article language is Turkish). The abstract should briefly include the rationale, aims, method, findings and recommendations of the research.

Keywords: At least 3 and at most 6 keywords that are not used in the title should be written 1 line below the abstract page, the first letter of each keyword should be capitalized and the others should be written in lowercase letters, if possible.

Main text: The main text of the article; Login; Material and Method; Results; Discussion and Conclusion; It consists of resources sections. All main section headings are written in capital letters and bold, and subheadings only the first letter of the first word is capitalized and bold. Headings and the beginning of the paragraph should start 0 cm indent. There should be a space between the paragraphs. Figures and tables should be placed at appropriate places in the article by giving figure and table numbers, table captions should be at the top of the table and figure captions should be given below the figure. Figure and table titles should be as short and descriptive as possible. If the figure is a picture, it should be of high resolution, and the graphic should be arranged in a way that is easy to understand. Only horizontal lines should be used in tables. If the local names of the living species or species that are the subject of the article are used, their scientific names should be stated in the first place in the text. For units, the international system of units should be used (The International Systems of Units, SI) and decimals should be indicated with a dot (.) (for example, 45.7% or 0.221).

Figures and Tables: Figures, graphics, photographs and the like should be specified as "Figure" and numerical values as "Table". All figures and tables should be embedded in the article. Figures and tables should be no more than 16x20 cm in length in single-page layout and 8 cm in width in double-column layout. The size of the figures and tables should be in a resolution that can be printed. Pictures supporting the research results should be in "jpg" format with 600 dpi resolution. Each table and figure should be cited in the text. All tables and figures should be numbered sequentially throughout the article (Table 1 and Figure 1). Table and figure titles and descriptions should be short and concise. Headings for figures and tables should be in 10 points, texts in figures and tables should be in 9 points, texts

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Units: SI (System International d'Units) measurement units should be used in all articles. Use a dot as a decimal fraction (like 1.25 instead of 1.25). "/" should not be used in units and a space should be given between units (such as m s-1 instead of m/s, J s-1 instead of J/s, kg m s-2 instead of kg m/s2). A space must be left between the number and the symbol (such as 4 kg N ha-1, 3 kg m−1 s−2, 20 N m, 1000 s−1, 100 kPa, 22 °C). Exceptions to this rule are the degrees, minutes, and seconds symbols (°, ′, and ″) used for planar angles. They should be placed immediately after the number (like 10°, 45′, 60″). The abbreviation of liter should be indicated as "l". If they are not at the end of the sentence, do not put a period at the end of the symbols (kg, not kg).

Formulas: Formulas should be numbered and the formula number should be shown in parentheses, aligned to the right next to the formula. Word math processor should be used in writing the formulas, main characters should be in 12 points, variables should be in italics, numbers and mathematical expressions should be given plain. If it is to be cited in the text, it should be given in the form of "Equation 1" (...the related model is given in Equation 1).

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Sources should be listed as in the following examples:

Journal articles:

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İÇİNDEKİLER

CONTENTS

EDİTÖRDEN

Değerli bilim insanlarımızın Karatekin Üniversitesi Fen Fakültesi Dergisi'ne sundukları beş özgün araştırma makalesini Aralık/2024 sayısında bilim dünyasına sunuyoruz.

Siz değerli okuyucuların ilgisine sunulan özgün araştırmalar arasında; *The Relationship of Nutrition and Leptin in Cancer, Electronic and optical properties of a screened donor impurity in a two-dimensional quantum dot under THz laser field* başlıklı makaleler bulunmaktadır.

Dergimizde yer alan makalelere çalışmalarınızda atıf yapılması, dergimizin ulusal ve uluslararası endeks ve dizinlerde yer almasına büyük katkı sağlayacaktır. Karatekin Üniversitesi Fen Fakültesi Dergisi'nin Aralık/2024 sayısının bilimsel çalışmalara katkı sunmasını temenni ediyorum.

Prof. Dr. Faruk KARAASLAN

Baş Editör

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Electronic and optical properties of a screened donor impurity in a two-dimensional quantum dot under THz laser field

THz lazer alanı altında iki boyutlu bir kuantum noktasında perdelenmiş donör safsızlığının elektronik ve optik özellikleri

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Quantum dot, THz laser, Optical properties, Screened Coulomb impurity

Abstract

Investigation of the intense THz laser field-related optical response of a two-dimensional parabolic quantum dot with on-center screened Coulomb impurity has been performed within the framework of high-frequency Floquet theory. The energy spectrum and wave functions of the system are obtained by using the finite element method while optical absorption coefficients and refractive index changes are calculated based on the compact-density matrix approach. Our results highlight the fact that action of intense laser field on the system leads to important modifications in the electronic and optical characteristics. Also, we found that the peak amplitude and position of optical coefficients can be adjusted by altering screening parameter and confinement strength. The controllability of these features could be useful for optimization of the optoelectronic devices.

Özet

Merkezde perdelenmiş Coulomb safsızlığına sahip iki boyutlu bir parabolik kuantum noktasının yoğun THz lazer alanına bağlı optik cevabının araştırılması, yüksek frekanslı Floquet teorisi çerçevesinde gerçekleştirilmiştir. Sistemin enerji spektrumu ve dalga fonksiyonları sonlu elemanlar yöntemi kullanılarak elde edilirken, optik soğurma katsayıları ve kırılma indisi değişiklikleri kompakt yoğunluk matrisi yaklaşımına göre hesaplanmaktadır. Sonuçlarımız, yoğun lazer alanının sistem üzerindeki etkisinin elektronik ve optik özelliklerde önemli değişikliklere yol açtığını vurgulamaktadır. Ayrıca, optik katsayıların pik genliği ve konumunun, perdeleme parametresi ve hapsetme şiddetinin değiştirilerek ayarlanabileceğini bulduk. Bu özelliklerin kontrol edilebilirliği optoelektronik cihazların optimizasyonunda faydalı olabilir.

1. INTRODUCTION

In recent years, studies on the electronic and optical properties of two-dimensional quantum dots (2DQDs), which possess extraordinary electronic and optical properties, have become important not only from the aspect of fundamental science but also for device applications (Barseghyan, 2015; Huang, 2013; Kumar, 2023; Mikhail, 2017; Shojaei, 2015). In particular, the physics of impurity states in QDs has become an important subject due to the modification of electronic and optical properties associated with impurity(Wang, 2019). Therefore, many researchers have focused on the intriguing impurity-related properties of QDs and have broadcasted a number of publications (Bera, 2016; Hashemi, 2015; Vala, 2017). Xie have investigated both the electric field and confinement effects on the impurity-related states and nonlinear optical rectification of a parabolic disc-like QD (Xie, 2009). Al-Hayek

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and Sandouqa have obtained the hydrogenic-like impurity binding energy of a Gaussian QD by using the method of the shifted 1/N expansion (AlHayek, 2015). The controllability of electronic properties and optical characteristics in an impurity doped quantum disc by magnetic field has been demonstrated by Niculescu and co-workers (Niculescu, 2017).

In most of the studies, the impurity potential in QDs is usually described by Coulomb potential (CP) (Coden, 2017; Kirak, 2022; Sheng, 2016) or Gaussian impurity (Ganguly, 2017; Halonen, 1996; Sarkar, 2016), while the Screened Coulomb (or the Debye-Yukawa) potential (SCP) (Varshni, 2001) is less preferred for impurity modeling. Although less studied in QDs, the SCP, which is a short-range potential and tends faster to zero than CP at $|\mathbf{r}| \to \infty$ limit (AlAhmadi, 2012; Poszwa, 2014), has been widely implemented in different areas such as atomic physics, nuclear physics, plasma physics, semiconductors, and quantum chemistry (Brum, 1984; Chang, 1988; Jiao, 2014; Soylu, 2008; Taseli, 1995). For instance, Ping and Jiang have investigated the effects of the charge screening on the exciton binding energy in GaAs-Al_xGa_{1-x} quantum wells (Ping, 1993). Villalba and Pino have presented the energy levels of a two-dimensional screened hydrogenic donor under a constant magnetic field (Villalba, 2002). They showed that the strength of screening parameter is considerably effective in consisting of the bounded states in 2D-screened hydrogen atom.

On the other hand, another important topic that is studied extensively is the effect of intense THz laser field (ITLF) on the behavior of impurity states in nanostructures. Due to the ability of ITLF on adjusting and controlling of electronic and optical properties of nanostructures, a great number of works have been reported by researchers (Aktas, 2016; Chakraborty, 2018; Ungan, 2019; Vinasco, 2019). Bejan and Niculescu have researched the influence of ITLF on the electronic and optical properties in an asymmetric double quantum dots (Bejan, 2016). Theoretical results given in Ref. (Brandi, 2004) show that the binding energies of donor impurities are affected by the intensity of the laser. The research of photoionization cross-section and impurity binding energy in GaAs-GaAlAs spherical quantum dots under electric and intense laser fields have been investigated by Burileanu and they found that increment in the electric and laser field intensities leads to diminishment in the magnitude of impurity binding energy (Burileanu, 2014). The other important research related to the effect of THz laser field on the shallow-donor impurity binding energy in GaAs semiconductors has been performed by Wang et al. and the obtained results show that the binding and transition energies depend on the laser field intensity and can be changed by tuning laser intensity (Wang, 2017).

As can be seen from the literature, many studies have been conducted on the optical and electronic properties of laser-driven QDs which include hydrogenic or Gaussian impurity. However, the effect of ITLF on the optical response of a 2DQD with an on-center screened Coulomb impurity has been not examined so far. The goal of this work is to investigate the electronic and optical properties of a 2DQD with impurity defined by SCP and irradiated by a THz laser. The structure of this paper is as follows: The theoretical framework is described in Section 2 and Section 3 is dedicated to discuss of the obtained results. Finally, a brief conclusion is given in Section 4.

2. MATERIAL AND METHOD

In this paper, we investigate the THz laser effect of an on-center donor impurity in a two-dimensional parabolic QD system. Presence of an impurity is described with SCP given as $V_{SC} = -e^{-\lambda r}/r$ where λ is screening parameter characterizing the shielding of the impurity ions. We assume that the system is irradiated by a non-resonant, monochromatic, circularly polarized ITLF of frequency Ω. Within the framework of non-perturbative theory, in the high-frequency regime the motion of electron is specified by the time-averaged dressed potential $\langle V_d(\mathbf{r}, \alpha_0)\rangle = \frac{1}{T}\int_0^T V(\mathbf{r} + \boldsymbol{\alpha}(t))dt$ where $T = 2\pi/\Omega$ is the period of ITLF. Here $\boldsymbol{\alpha}(t) = \alpha_0(\hat{x}\cos\Omega t + \hat{y}\sin\Omega t)$ corresponds to the motion of the electron in the ITLF and the $\alpha_0 = eA_0/m^*\Omega$ is the laser-dressing intensity parameter. Time-independent Schrödinger equation governing the effects of high-frequency radiation for the zeroth Floquet component (φ_{nm})

with corresponding quasienergy (ε_{nm}) is given:

$$\left[\frac{\mathbf{p}^2}{2m^*} + \langle V_{dP}(r,\alpha_0)\rangle + \langle V_{dSC}(r,\alpha_0)\rangle\right]\varphi_{nm}(r) = \varepsilon_{nm}\varphi_{nm}(r)\ . \tag{1}$$

Here the radial and magnetic quantum numbers are depicted by n and m, V_{dP} and V_{dSC} corresponds to the laser-dressed form of parabolic confinement and screened Coulomb impurity potentials, respectively. In this study, we have numerically carried out the calculation of eigen energies with corresponding eigen functions by using one-dimensional finite element method (FEM) based on Galerkin approach. This approach identified in a weak formulation is a variational expansion method and the basis functions are local, piecewise polynomials in real space. For the survey of the optical response of the system, we have considered the dipole transitions allowed only between states satisfying the selection rule $\Delta m = \pm 1$. Therefore, we have selected the energy levels and the wave functions participating in the transitions to be $E_0 = \varepsilon_{00}$, $E_1 = \varepsilon_{11}$ and $\psi_0 = \varphi_{00}$, $\psi_1 = \varphi_{11}$.

The linear and third-order nonlinear optical absorption coefficients (OACs) for intersubband transitions are obtained by means of the compact density matrix approach and iterative scheme:

$$\alpha^{(1)}(\omega) = \omega\sqrt{\frac{\mu}{\epsilon_r}}\frac{\sigma_s|M_{10}|^2\hbar\Gamma_0}{(E_{10}-\hbar\omega)^2+(\hbar\Gamma_0)^2} \tag{2}$$

$$\begin{aligned}\alpha^{(3)}(\omega,I) &= -\omega\sqrt{\frac{\mu}{\epsilon_r}}\left(\frac{I}{2n_r\epsilon_0 c}\right)\frac{\sigma_s\hbar\Gamma_0|M_{10}|^2}{\left[(E_{10}-\hbar\omega)^2+(\hbar\Gamma_0)^2\right]^2}\\ &\times\Big\{4|M_{10}^2| - |M_{11}-M_{00}|^2\\ &\times\frac{\left[3E_{10}^2 - 4E_{10}\hbar\omega + \hbar^2(\omega^2-\Gamma_0^2)\right]}{E_{10}^2+(\hbar\Gamma_0)^2}\Big\},\end{aligned} \tag{3}$$

and the total OAC can be written as $\alpha(\omega,I) = \alpha^{(1)}(\omega) + \alpha^{(3)}(\omega,I)$. Here ϵ_0 and μ are the electric and magnetic permeability, σ_s is the carrier density, I is the intensity of the incident light with x-polarization, n_r is the refractive index of medium, c is the vacuum speed of light, E_{10} denotes the transition energy between the states, $M_{ij} = |\langle\psi_i|er\cos\phi|\psi_j\rangle|$ $(i,j=0,1)$ are the off-diagonal matrix elements of the dipole moment and $\Gamma_0 = 1/T_0$ is phenomenological operator.

The expressions of linear and the third-order nonlinear relative refractive index changes (RICs) are given by, respectively:

$$\frac{\Delta n^{(1)}(\omega)}{n_r} = \frac{1}{2n_r^2\epsilon_0}|M_{10}|^2\sigma_s\left[\frac{E_{10}-\hbar\omega}{(E_{10}-\hbar\omega)^2+(\hbar\Gamma_0)^2}\right] \tag{4}$$

and

$$\begin{aligned}\frac{\Delta n^{(3)}(\omega,I)}{n_r} &= -\frac{\mu c}{4n_r^3\epsilon_0}|M_{10}|^2\frac{\sigma_s I}{\left[(E_{10}-\hbar\omega)^2+(\hbar\Gamma_0)^2\right]^2}\\ &\times\big[4(E_{10}-\hbar\omega)|M_{10}|^2\\ &-\frac{(M_{11}-M_{00})^2}{E_{10}^2+(\hbar\Gamma_0)^2}\left\{(E_{10}-\hbar\omega)\right.\\ &\times\left[E_{10}(E_{10}-\hbar\omega)-(\hbar\Gamma_0)^2\right]\\ &-\left.(\hbar\Gamma_0)^2(2E_{10}-\hbar\omega)\right\}\big]\ .\end{aligned} \tag{5}$$

The total magnitude of the RIC is written as $\Delta n(\omega,I)/n_r = \Delta n^{(1)}(\omega)/n_r + \Delta n^{(3)}(\omega,I)/n_r$.

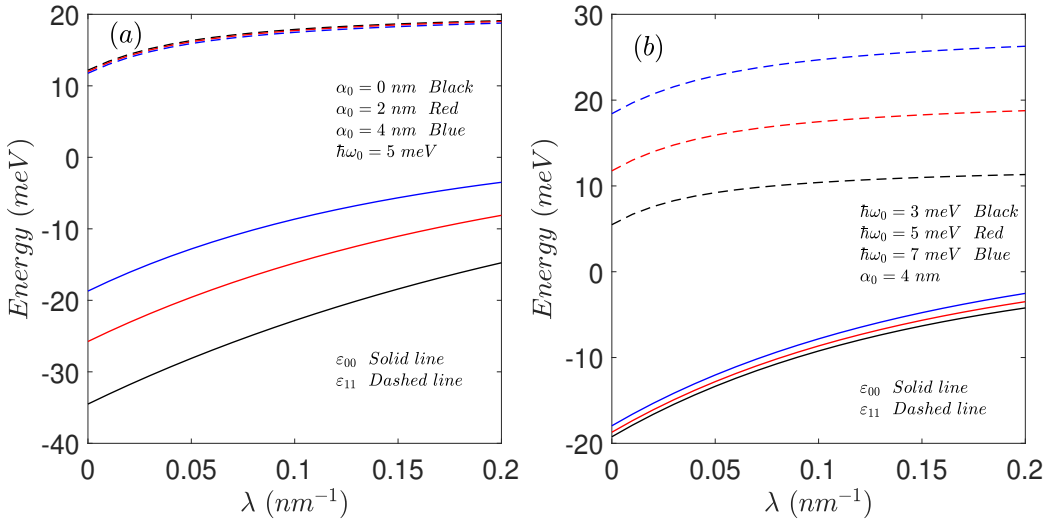

Fig. 1. Variation of energies of E_0 and E_1 as a function of the screening parameter for different values of (a) laser-dressing parameter and (b) confinement strength.

3. RESULTS

In this section, we present and discuss the numerical results concerning the influence of THz laser field on a typical GaAs quantum dot structure with an on-center screened impurity. The physical parameters used in our calculations are: $m^* = 0.067\, m_0$ (m_0 being the free electron mass), charge density of $\sigma_s = 5 \times 10^{24}\ m^{-3}$, $T_0 = 0.14$ ps, $\mu = 4\pi \times 10^{-7}$ Hm^{-1}, $n_r = 3.2$ and $I = 1.5 \times 10^{10}$ W/m^2.

Before discussing the optical response of the system, it would be beneficial to investigate the effect of screening parameter on the energy states. Hence, the dependence of energies E_0 and E_1 on $\lambda-$parameter for several values of laser-dressing parameter and confinement strength is presented in Fig. 1. As is apparent from Fig. 1 (a), the increase of α_0 leads to a significant rise in the E_0 whereas E_1 is less affected. In Fig. 1 (b), we can clearly see that augmentation in $\hbar\omega_0$ gives cause for a remarkable increase in E_1 while inducing relatively less increase in the ground-state energy. As is seen from both figures, the greater values of $\lambda-$screening parameter bring about a notable enhancement in the energies.

In attempt to understand the behavior of the ground-state binding energy of the laser-dressed system with screened Coulomb impurity, in Fig. 2 we present the variation of binding energy as a function of laser-dressing parameter for three values of λ and $\hbar\omega_0$. Binding energy is defined by $E_b = E_0^0 - E_0$ where E_0^0 states the ground state energy in the absence of impurity. Fig. 2 (a) displays an appreciable diminishment in the magnitude of binding energy for higher values of λ. Increment of screening effect brings about weakening interaction between impurity and electron which explains the behavior in Fig. 2 (a). On the other hand, strengthening in confinement potential brings about an increase in the binding energy as seen from Fig. 2 (b). The physical reason can be explained by the fact that the greater values of $\hbar\omega_0$ give rise to more localized impurity-related states because of stronger quantum confinement and increment of absolute Coulomb interaction. Moreover, from Fig. 2 (a) and (b) we observe that the magnitude of impurity binding energy demonstrates a remarkable decline with increasing laser-dressing parameter owing to increment in the electron-impurity distance, which causes weakening in the strength of the Coulomb interaction.

The investigation of the influences of λ and $\hbar\omega_0$ on the dipole matrix element ($|M_{10}|$) is important for better understanding of the optical response of the system under ITLF. Therefore, in Fig. 3 we exhibit the change of magnitude of $|M_{10}|$ as a function of α_0 for different values of λ and $\hbar\omega_0$. It is clear from Fig. 3 (a) that the magnitude of $|M_{10}|$ showing an increasing behavior up to specific value of α_0 is followed by a decrease. In addition, the augmentation of $\lambda-$parameter leads to an increment in the absolute value of $|M_{10}|$. Fig. 3 (b) depicts that the dipole matrix element declines considering higher values of $\hbar\omega_0$. In this figure, remarkable observation is that the magnitude of $|M_{10}|$ enhances

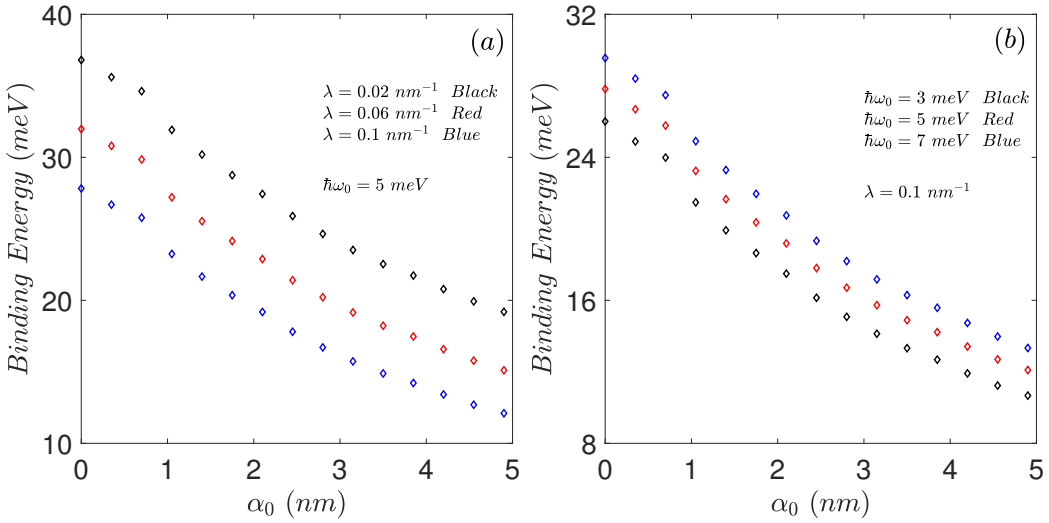

Fig. 2. Binding energy as a function of laser-dressing parameter for different values of (a) $\lambda-$parameter for confinement of 5 meV, (b) the confinement strength for a fixed $\lambda = 0.1$ nm^{-1}.

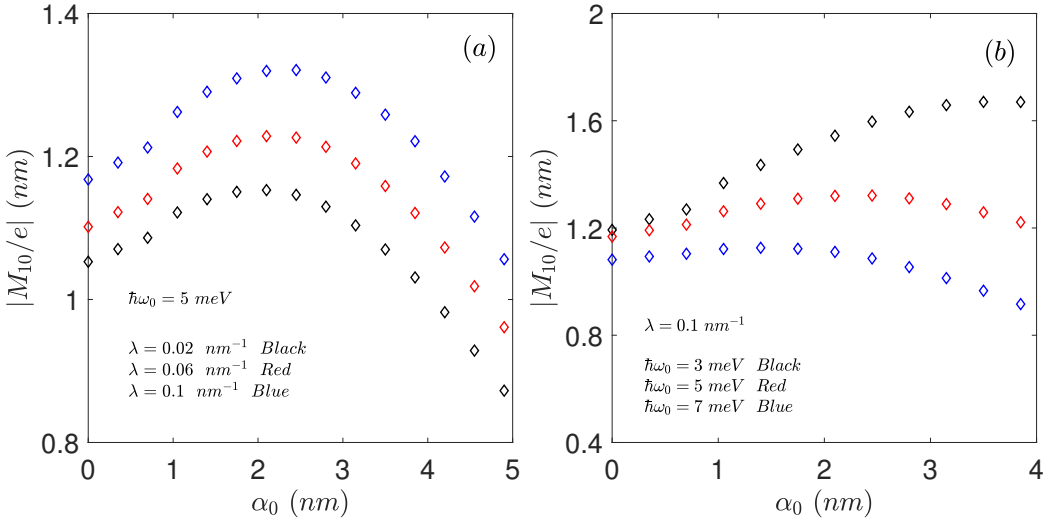

Fig. 3. Plot of $|M_{10}|$ as a function of the laser-dressing parameter for three values of (a) screening parameter and (b) confinement strength.

with increasing α_0 at the lowest value of $\hbar\omega_0$. However, for the greater values of $\hbar\omega_0$, the variation of $|M_{10}|$ depicts a similar behavior as Fig. 3 (a).

To investigate the effect of intense laser field on the optical response of the system, we display the variation of the OACs and RICs as a function of incident photon energy for $\lambda = 0.1$ nm^{-1} with $\hbar\omega_0 = 5$ meV in Fig. 4. It would be important to remark that the dashed, dotted and solid lines indicate the linear, third-order nonlinear and the total optical characteristics, respectively. The greater values of α_0 lead to a diminishment in the height of the resonance peaks of the OACs whereas cause an increment in the magnitude of RICs. The physical interpretation of Fig. 4 can be explained by the change in the absolute value of dipole matrix element by the increase in the α_0-parameter and this result is consonant with Fig. 3. The peak positions of OACs and RICs move to the lower energy values (red-shift) with increasing α_0 owing to diminishment in the energy interval between states E_0 and E_1, which could be easily seen in Fig. 1 (a).

Another important examination on the optical characteristics of the system is the effect of screening. Therefore, the variations of the optical coefficients as a function of incident photon energy for several values of $\lambda-$secreening parameter considering the fixed values $\alpha_0 = 4$ nm and $\hbar\omega_0 = 5$ meV

are shown in Fig. 5 (a) and (b). It can be clearly observed that in compliance with the previously presented energy and $|M_{10}|$ data, increment in $\lambda-$parameter leads to an increase in the peak heights of the linear, third-order nonlinear and total OACs and RICs while the peak positions of OACs and RICs shift toward to the lower energy region.

Fig. 6 demonstrates the variation of optical absorption coefficients and refractive index changes versus the photon energy for different confinement strength for laser-dressing parameter of 4 nm. From both figures, we evidently observe that augmentation of confinement strength brings about a considerable reduction in the amplitudes of OACs and RICs. Besides, strengthening in confinement causes a blue-shift in the optical response on account of enhancement in the transition energy.

It may be significant also to examine the effects of the screening parameter and confinement frequency in the magnitude of resonant peak values of total OAC and RIC. Hence, Fig. 7 (a) and (b) depict the changes in the peak values of OAC and RIC at resonance frequency as a function of α_0 for different values of λ and $\hbar\omega_0$.

The main figures of Fig. 7 (a) and (b) shows that the resonant peak values of OAC and RIC increase for greater values of λ and exhibit a decreasing behavior for stronger laser field. From the inset figure of Fig. 7 (a), the noticeable behavior for the maximum value of total absorption coefficient is readily seen. The highest value of $|\alpha_{tot}|_{max}$ is obtained for a specific confinement strength value ($\hbar\omega_0 = 7$ meV) at lower laser dressing parameters whereas it is highest for $\hbar\omega_0 = 3$ meV at greater values of α_0. From the inset figure of Fig. 7 (b), it can be readily seen that the maximum value of total RIC decrease for higher values of $\hbar\omega_0$. Further, the resonant peak of RIC increases for lower values of α_0 value but this magnitude starts to decline with the strengthening in the ILF.

4. DISCUSSION AND CONCLUSION

In this work, investigation on the electronic and optical properties of a laser-driven 2DQD including a screened Coulomb impurity has been performed. The influence of non-resonant, circularly polarized ITLF has been tackled within the framework of Floquet approach and effective mass approximation. The numerical solution of Schrödinger equation of system is achieved by the use of FEM. The numerical results demonstrate that exposing an ITLF onto a 2DQD system results in remarkable changes in the impurity binding energy, dipole moment matrix elements and the optical characteristics of the system. By altering the magnitude of confinement frequency, laser-dressing and $\lambda-$screening parameter, shifts in the resonant peak positions of OACs and RICs are observed. On the other hand, enhancement in the peak amplitudes of OACs and RICs is observed for the lower values of α_0 and $\hbar\omega_0$ while this increment is seen with increasing the screening effect. In brief, results of this work reveal that the confinement

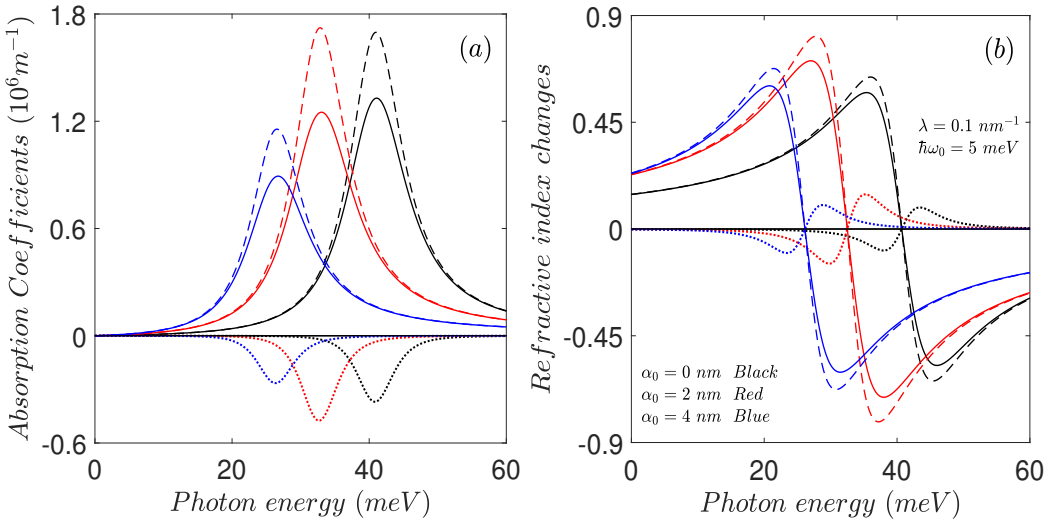

Fig. 4. The change in the linear, third-order nonlinear and total (a) OACs and (b) RICs as a function of the photon energy for three values of α_0 with $\lambda = 0.1$ nm^{-1} and $\hbar\omega_0 = 5\ meV$.

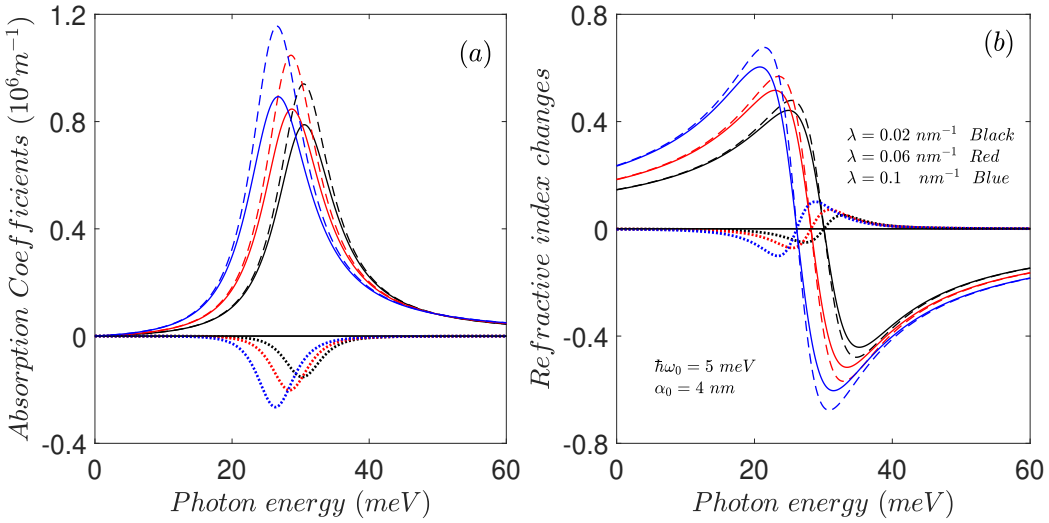

Fig. 5. (a) Optical absorption coefficients and (b) refractive index changes versus incident photon energy for different values of $\lambda-$screening parameter.

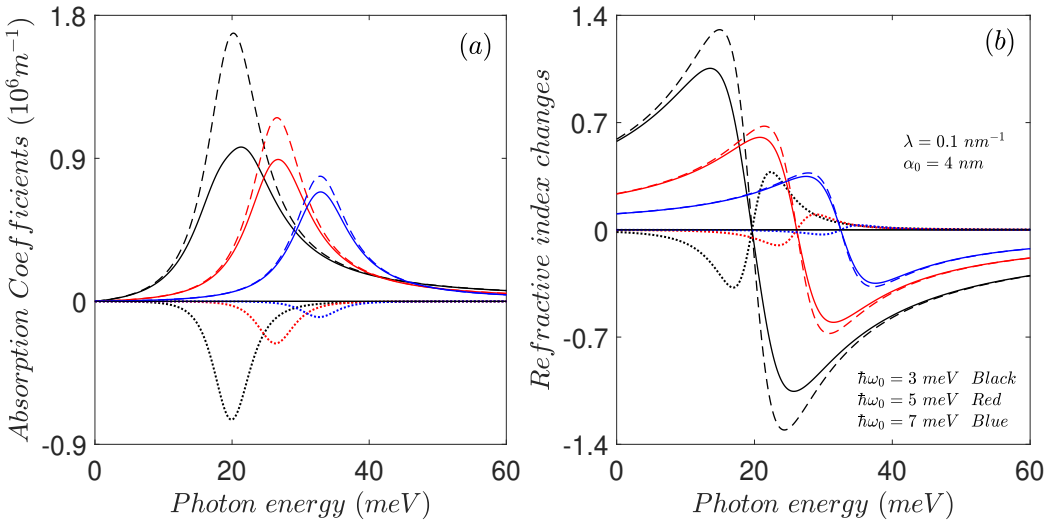

Fig. 6. (a) OACs and (b) RICs vs the photon energy for different values of $\hbar\omega_0$. We set $\alpha_0 = 4$ nm and $\lambda = 0.1$ nm^{-1}.

strength, screening and laser-dressing parameters can be used to control the optical response of the system which can provide an assistance to impurity-doped QD device applications.

Author Contributions

All authors contributed equally to this work. They all read and approved the last version of the paper.

Conflicts of Interest

All authors declare no conflict of interest.

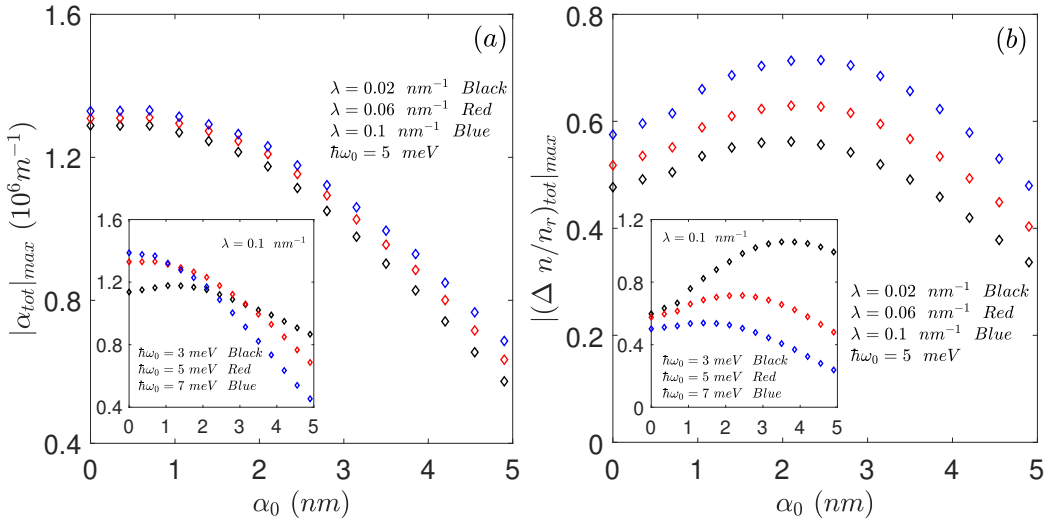

Fig. 7. The maximum values of OACs and RICs versus α_0 for varying values of λ. The insets show the dependence of $\hbar\omega_0$ on the maximum values of OACs and RICs as a function of α_0.

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The Relationship of Nutrition and Leptin in Cancer

Beslenme ve Leptinin Kanserle İlişkisi

Aysel SARI[1]

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Abstract

Leptin hormone has an important role in the consumption of excessive food intake and energy expenditure. While leptin acts as a neuroendocrine hormone, it has an important role in metabolic function. Leptin shows peripheral effects on glucose metabolism and gluconeogenesis, and it is aimed to emphasize its importance in its relationship with nutrition. Malnutrition, which is a serious risk for cancer development and progression, also causes bad negative results in many tumor types. Nutritional balance and energy balance are affected at the level of insulin and leptin hormones, and functionality is important on the relationship between nutrition and leptin and cancer. The negative effects on adipose tissue caused by unbalanced nutrition are effective in cancer formation and insulin, insulin resistance, that is, leptin levels. In addition, many studies have reported that unbalanced nutrition tumor damage.

Özet

Leptin hormonunun aşırı besin alımı ve enerji harcamasında önemli bir rolü vardır. Leptin nöroendokrin bir hormon gibi davransa da metabolik fonksiyonda önemli bir role sahiptir. Leptinin glukoz metabolizması ve glukoneogenez üzerinde periferik etkiler gösterdiği ve beslenme ile ilişkisinde öneminin vurgulanması amaçlanmaktadır. Kanserin gelişimi ve ilerlemesi açısından ciddi bir risk olan yetersiz beslenme, birçok tümör türünde de kötü olumsuz sonuçlara neden oluyor. Beslenme dengesi ve enerji dengesi insülin ve leptin hormonları düzeyinde etkilenmektedir ve beslenme ile leptin ve kanser arasındaki ilişkide işlevsellik önemlidir. Dengesiz beslenmenin yağ dokusu üzerinde yarattığı olumsuz etkiler kanser oluşumunda ve insülin yani insülin direnci yani leptin düzeylerinde etkilidir. Ayrıca birçok çalışma dengesiz beslenmenin tümörlere zarar verdiğini bildirmiştir.

1. INTRODUCTION

Cancer, which is the second leading cause of death in the world, is defined as "metastasis" by growing excessively within the body's own limits. As it spreads in the organs, an abnormal increase in the number of cells occurs. As a result of excessive cell proliferation in this way, common cells with deterioration in their properties are called cancer (Futreal *et al.* 2001 and Haber 2000). Metastasis is the most common cause of death from cancer. Most of the deaths that occur are types of cancer in men; stomach, lung, liver, prostate, colorectal and esophagus; In women, breast, stomach, lung and colorectal cancers are observed. Cancer differs according to type, age, gender and geographical regions (Parkin 2000).

It has been reported that the increase in the number of cancers and therefore the morbidity and mortality associated with cancer may be a continuation of the increase (Pisani *et al.* 1999 and Eaton 200). Mutagenic substances, which are particularly effective in the formation of cancer, bind to the DNA of carcinogenic agents

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and cause damage. Nutrition is important as the protective mechanism of the gene in this type of damage. Conservation of genes can be achieved largely through nutrition (Doll *et al.* 1981 and Alexandro *et al.* 2002).

Leptin is a regulator of body weight and energy balance acting in the hypothalamus in 1994. Leptin is a protein hormone consisting of 146 amino acids. Leptin hormone is secreted from adipocytes. High levels of plasma leptin are stored by adipose tissues. Fat cells secrete leptin. In animals and humans, leptin is an important regulator of energy balance The energy balance created by this hormone affects the immune system (Zhang, *et al.* 1994; Bjorbaek *et al.* 2004; Correia *et al.* 2004; Hukshorn *et al.* 2004; Mark *et al.* 2004; Meier *et al.* 2004; Hussain *et al.* 2017).

Leptin hormone is secreted from adipocytes. It acts as a neuroendocrine hormone in energy expenditure to regulate excessive food intake (Faust *et al.* 1977). Therefore, it has a significant impact on metabolic function (Sari 2013). For example, in studies on the mechanism of adipose tissue derived cancers; Hormonal related organs such as breast cancer, excessive adipose tissue increase are associated with tumor growth (Sierra-Honigmann *et al.* 1998; Ahima *et al.* 2000; Miyazawa-Hoshimoto 2004).

Nutrition and energy balance are very important. Insulin and leptin hormones are affected in this balance, and it is important on the relationship between nutrition, leptin and cancer. It is aimed to emphasize that the studies on this subject are very important.

Leptin levels should be known in cancer patients. The relationship of cancer with nutrition is known and its importance in this regard should be evaluated in all aspects. Cancer nutrition and leptin relevance should be considered as a study.

1.1. Cancer and Nutrition

Bacteria, viruses, radiation, heredity, the effect of the environment and wrong habits in nutrition and the effects of chemicals on cancer have been proven (Williams 1992 and Williams 2001). The idea that nutrition carries a risk for cancer was expressed by Yong-He Yan in 1270. It was reported by Wisemen in 1676 that malnutrition would effectively cause cancer (Nixon 1990).

Studies have shown that cancer can be prevented and reduced by at least a third with dietary changes (Terry *et al.* 2002 and Peeters 2005). The interaction of glucose, which is a carbohydrate, with insulin level is known. The effect between cancer and dietary carbohydrates has been investigated. The relationship is not clear. However, an interaction between glucose and insulin levels has been reported (Warren 2016).

Consuming fibrous food ensures regular functioning of the intestines. It has a role in preventing constipation. It was determined that dietary fiber reduces the excretion of carcinogenic substances from the intestines and the risk of cancer (Byers *et al.* 2002). In some studies, it has been shown that wheat bran is not protective (Alberts *et al.* 2004). From carbohydrates, whole grains (processed consumption of products such as rice, millet, wheat, barley, oats, corn and barley) vegetables, fruits, vitamins and minerals are anticarcinogenic compounds. There are studies showing that cereal shells are rich in fiber and reduce the risk of cancer, but this decrease is not significant (Cui *et al.* 2006). Cancer cells use sugar more than healthy cells. It is known that sugar feeds cancer and leads to obesity and insulin resistance that occur with excessive consumption of flour and sugar. It has also been found that fasting hyperglycemia and/or diabetes increase the risk of cancer (Ha Jee *et al.* 2005 and Cooney *et al.* 2005). Cancer mortality increases in individuals with high glucose concentrations (Kakehi *et al.* 2018).

Proteins serve as building blocks of cells in the body. Treatment methods such as cancer, chemotherapy and radiotherapy increase the need for protein (Roslan *et al.* 2022). The effect of selenium and vitamin E in prostate cancer has been determined (Clark *et al.* 1996). Selenium has been reported as an anticarcinogenic substance (Redman *et al.* 1998 and Thompso *et al.* 1994). In addition, vitamin E has the ability to stop the growth of many cancers (Israel *et al.* 1995). The World Cancer Research Fund (WCRF)/American Institute for Cancer Research (AICR) and the American Cancer Society state that care should be taken in the diet of

cancer patients, especially red and processed meat consumption should be limited. Emphasizes plant based natural intensity consumption (Mourouti *et al.* 2017).

Vegetables and fruits should be consumed more frequently in the diet. Also, carbohydrates such as processed sugars (cakes, biscuits, etc.) should be reduced. It should be fed with a diet low in fat. Food should be consumed fresh. Processed, cooked at high temperatures or fried should not be preferred. It is important to be at a healthy weight. It should be of plant origin and a small amount of nutrition and low calorie intake. Physical activities and daily exercise programs should be done. It has been observed that such a lifestyle especially reduces the risk of cancer (Slat Tery *et al.* 1997). Alcohol intake should be reduced. It has been reported that the risk of cancer increases with the increase and continuation of alcohol consumption (World Cancer Research Fund 1997). In a study in women, an association was found between increased alcohol intake cancer (Smith-War ner *et al.* 1998). A decrease in cancer is observed with fish consumption, and it is reported that the risk of cancer decreases with omega-3 fatty acids obtained from fish (Kim *et al.* 2009). It has been found that dietary intake of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which are in the omega-3 fatty acid group, reduces the risk of cancer (Carol *et al.* 2015).

Calcitriol is a steroid hormone. It has been found to have broad spectrum anti-tumor activity in many studies (Ma *et al.* 2015).

In studies investigating the relationship between vitamin B12 and cancer, it was observed that there was no consistency between plasma vitamin B12 concentrations and cancer, except for liver cancer. Less consistent associations with cancer have been identified between vitamin B12 intake from food or supplements. However, it is stated that low vitamin B12 concentrations are detected in the plasma of cancer patients (Obeid 2022).

It is known that there is a relationship between nutrition and vitamins in cancer treatment. Data based on very new information about the micronutrient group as cancer preventive agents are presented. Folate, methionine, vitamins B6, B12, micronutrients with antioxidant properties (such as vitamins E, selenium) have an important role in cancer. Consumption of vitamin B6 with food is significantly anticancer in cancer. In addition, dietary selenium has a significant positive effect in cancer sites. Nutritional vitamins E and C were statistically significant in cancer (Kune and Watson 2006).

An unbalanced diet with micronutrients in foods (vitamins A, B, E, D, C, K zinc, iron, selenium, and iodine) may also increase the risk of cancer and cause cellular damage (Venturelli *et al.* 2021). Vitamin C also plays a protective role in cancer types in which nitrosamines play a role, by inhibiting the formation of nitrosamines (Byers and Perry 1992).

Iron deficiency is very important in terms of nutrition and has been associated with cancers of the upper digestive tract (Benamouzing and Chaussade 1999).

Carotenoid group foods, especially tomatoes containing lycopene, have positive effects in many cancer types, especially in cancer (Hadley *et al.* 2002).

1.2. Cancer and Leptin

Many studies have stated that leptin has antiapoptotic and mitogenic effects in different cancer cell lines in vitro (Hardwick *et al.* 2001 and Aparicio *et al.* 2005). It is known to examine the effects of nutrition and leptin in cancer treatment and prevention. The leptin concentration in serum rises with the adverse effects of unbalanced nutrition, which is a process associated with increased fat mass and growth of adipocytes and increased leptin secretion (Hamilton *et al.* 1995 and Kolaczynski 1996). While leptin is known to be essential for mammary gland development in humans, subsequent studies have suggested that it plays a role in mammary carcinogenesis (Smith-Kirwin *et al.* 1998; O'Brien *et al.* 1999; Cleary *et al.* 2003). Leptin is observed to be significantly increased in cancer tissue (Ishikawa *et al.* 2004). The relationship between leptin signaling and cancer is now known (Hardwick *et al.* 2001 and Rouet-Benzineb *et al.* 2004). In vitro studies have demonstrated the level of activity of leptin on epithelial cells (Liu *et al.* 2001).

There are studies of leptin on the development of cancer. It has been reported that leptin has an effect that can enlarge and increase cancer cells (Cioffi *et al.* 1996; Stattin *et al.* 2001 and Somasundar *et al.* 2004). It has been suggested that the risk of developing cancer increases as a result of an unbalanced diet (Moller *et al.* 1994; Michaud *et al.* 2001 and Calle *et al.* 1995).

Although the serum leptin concentration is significantly higher in the cancerous organ, leptin levels return to normal with the balanced formation of insulin values during the treatment process (Popovic *et al.* 1998). Cancer patients, low leptin concentration is associated with increased insulin resistance (Barber *et al.* 2004). Recent studies have drawn attention to the possible role of leptin in cancer development and progression. Disturbances caused by malnutrition are associated with increased leptin levels. It has been determined that the hormone leptin is indirectly effective as a risk factor in cancer (Hoda *et al.* 2007). When patients with thyroid cancer were compared with the control group, it was determined that elevated serum leptin levels were significant (Hedayati *et al.* 2011).

2. CONCLUSION

It is very important to draw attention to this issue in order to examine the molecular mechanisms, effects and role of leptin in cancer. Several studies have addressed the possible role of leptin in cancer development and progression. It is inevitable to concentrate on studies on leptin nutrition and cancer. The number of cancer survivors is increasing and one of the factors affecting this issue is nutrition. Its relationship with nutrition and physical activity has been observed in studies.

Author Contributions

In this study, the final version of the draft was read and approved.

Conflict of Interest

The author declares that he is the only author with whom he has no conflict of interest.

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