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Pitout JDD, Church DL, Gregson DB, Chow BL, McCracken M, Mulvey M, Laupland KB (2007). Molecular epidemiology of CTXM-producing Escherichia coli in the Calgary Health Region: emergence of CTX-M-15-producing isolates. Antimicrob. Agents Chemother. 51: 1281-1286.

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Full Length Research Paper

Determinants of nutritional behaviour of secondary school students in Akwa Ibom State, Nigeria

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The researchers' purpose in the study was to assess the determinants of nutritional behaviour of secondary schools students in Akwa Ibom State, using a descriptive survey design. Five research questions and three null hypotheses were verified in the study. The determinants of nutritional behaviour (DNB)" questionnaire was used to collect data from a multi-stage simple random sample of 450 drawn from the 1320 Senior Secondary II students in the State. Percentage analysis of data revealed a high positive score of 69.2% on knowledge of nutritional values, and a high positive score of 61.5% on the nutritional behaviour of students. Findings from Chi-square analysis revealed that knowledge of nutrition, family income and gender had significant influence of the nutritional behaviour of secondary school students in the state. Based on the findings, it was recommended that planned and consistent nutrition education should be undertaken to sustain and improve the level of knowledge and nutritional behaviour of students. Also, government should formulate policies that will improve on the social and economic status of people, while intensifying the poverty reduction programmes at the various levels.

Key words: Students nutritional determinants, knowledge, behaviour, values.

INTRODUCTION

Individuals in different sectors of the population devise and adopt ways or pattern of eating. These adherence and practices of feeding may be referred to as nutritional pattern. Ekpenyong (1998) referred to such adherence as nutritional behaviour. According to him, nutritional behaviour refers to food consumption habit, choice or selection or the adopted pattern of eating by different groups of people in the community. In this study, therefore, nutritional behaviour refers to choice or proclivity and actual food consumption practice of students in secondary schools in Akwa Ibom State. Meeting the nutritional requirements for growth and development at this rapid growth spurt, demands adequate quantity and quality intake of food by secondary school students the world over. Good nutrition involves eating the right combination of a variety of nutrients in their proper quantity. A number of factors, however, influence what an individual eats or not and such factors determine nutritional habit, behaviour, or practices of people. Okafor (1997) submitted that determinants of nutritional practices are those factors or variables responsible for adoption of the nature of food consumed. Such variables, in his view include sex, family income, environmental conditions, religious affiliation, availability of food items, knowledge of food value and cultural significance, among others. Similarly, Ekpenyong opined that food intake depends on the nutritional needs of an individual and that this varies with age, growth rate, amount of work done, state and knowledge of nutrition, and state of health.

Evidence is replete in literature to attest that the school plays a vital role in shaping behaviour through a life span (WHO, 1997). Thus, students with good nutritional habits manifest socially, mentally, and physically alert personality. Surprisingly, Ekeh (1996) and Ekpenyong (1998) seem to suggest that students in secondary schools neither possess adequate knowledge of nutritional values nor practise good nutritional behaviour. As a result, such students manifest poor health

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development, poor eye sight, skin blemishes, and reduced appetite, among others. It is expected that knowledge of nutritional values should enable students to know the type of foods they need to consume each day to obtain essential nutrients their body needs for proper functioning. Furthermore, the nature of food produced, processed and distributed is changing rapidly owing to the scientific revolution in agriculture and technology. If these changes must produce good results, sound knowledge of the principles of nutrition is required. Burma (1991) noted that students, like everyone else, need sound and practical knowledge that can direct their food choices to ensure sound nutrition. This implies that knowledge acquired through nutrition education should help children especially secondary school students to examine their food intake and establish judicious eating habits.

Surprisingly, Ekeh (1996), the World Health Organization (WHO; 1997) and Ekpenyong (1998) asserted that the high level of malnutrition among students in Nigerian schools is attributable to poor nutritional knowledge and habit and other factors which substantially influence pattern of food consumption. Samuel (2001) also pointed out that children, especially secondary school students, have many health and nutritional problems resulting from many factors including lack of knowledge and their age characteristics. Since schools provide nutrition education, it is expected that students should possess necessary nutritional knowledge for their maximum benefits and life-long application. Besides, nutrition education in schools is capable of exerting significant influence on knowledge of nutritional values and acceptance of healthful nutritional habits. For instance, experts tend to show that students with good nutritional habit manifest alertness and zeal towards various activities in school, and perform academically better than poorly-fed children (Okafor, 1997; WHO, 1997).

Regrettably, Nwana (1996) reported that knowledge about nutrition and health-related matters was low among secondary school students in Enugu State. This situation is worrisome. In view of the socio-cultural similarities of Enugu State with the area of study it is possible that a similar trend may occur. Based on this premise, the researchers were challenged to investigate the determinants of nutritional behaviour in secondary schools in Akwa Ibom State, Nigeria, as a prelude to determining baseline data for nutrition intervention programmes in the State. In order to provide direction for the investigation, the following specific objectives were posited, namely to:

(i) determine the level of knowledge of nutritional values among secondary school students in Akwa Ibom State;
(ii) determine nutritional behaviour of secondary school students in Akwa Ibom State;
(iii) determine the relationship between the knowledge of nutritional values and nutritional behaviour among secondary school students in Akwa Ibom State;
(iv) assess the influence of family income on nutritional behaviour of secondary school students in Akwa Ibom State and
(v) ascertain the influence of gender on nutritional behaviour of secondary school students in Akwa Ibom State.

RESEARCH METHOD

The descriptive survey design was used for the study. This was considered suitable since data was required in their natural distribution in the population. According to Akpabio and Ebong (2009) this design is relevant when the researcher is required to undertake a systematic collection, analysis, and presentation of data to give account of the characteristics of particular individuals, groups, or the state of events without the manipulation of data as applicable in experimental studies. A similar design was successfully used to assess the reasons for non-use of HIV/AIDS screening services in Akwa Ibom State (Akpabio and Ikorok, 2007). This design was, therefore, considered relevant for the study.

Population for the study

The population comprised 1,320 Senior Secondary II (SSII) students in public secondary schools in the Akwa Ibom State (Akwa Ibom State Ministry of Education, 2009). This comprised both male and female students from government secondary schools in the area.

Sample and sampling technique

A multi-stage simple random sample of 450 students was drawn from 1320 SSII students in public secondary schools in Akwa Ibom State Nigeria. This comprised 34% of the population and was considered adequate for the study (Udoh and Joseph, 2003). First, a ballot sample of five schools was drawn from the three Senatorial Districts of the State, namely; Ikot Ekpene, Uyo and Eket. Thereafter, 150 students from each of the schools were drawn through basket and paper balloting. The first 30 students whose names were picked from the basket in each of the classes were listed for the study. However, only 420 copies of the questionnaire retrieved were found treatable. Therefore, the analysis for this study was based on the 420 participants.

Instrument for data collection

A 42-items questionnaire, entitled “Determinants of Nutritional Behaviour (DNB)” was developed by the researcher, and used for data collection in the study. It was designed in two sections: Section A, which comprised indices for gathering demographic data; while Section B was organised for eliciting information based on the objectives of the study on Agreed and Disagreed non-weighted responses.

Validation of the instrument

The face and content validity was ascertained by the judgement of five experts, two each in health education, measurement and evaluation, and one in nutrition from the University of Uyo. Based on the majority opinion of the experts, an item was considered suitable for inclusion in the instrument.

Table 1. Percentage analysis of knowledge of nutritional values (n = 420).

S/N	Items	Correct (%)	In-correct (%)
1	Nutrient is an important substance needed by the body for growth.	100.0	0.0
2	The six types of nutrients needed by the body are protein, carbohydrate, fat and oil, minerals and vitamins.	66.9	33.1
3	Protein builds up the body and replaces worn out tissues.	72.4	17.6
4	Sources of protein include meat, beans, fish, eggs, snails, milk, and soya beans.	97.9	2.1
5	Plant proteins are not necessary source of protein.	33.4	67.6
6	The end product of protein is amino acid.	36.7	63.3
7	Protein is the necessary substance for body growth in children.	82.9	17.1
8	Rice, cassava, yam, maize, cocoa yam, millet, and wheat are energy giving food items.	24.5	75.5
9	Digestion of starchy foods results in glucose.	84.5	15.5
10	Energy giving foods help in performing activities requiring weight.	71.2	26.8
11	Fatty foods help to regulate body temperature.	90.0	10.0
12	Protective foods are minerals and vitamins.	23.3	76.7
13	Protective foods are useful for body growth.	68.8	31.2
14	Protective foods are also needed for body building and bones.	92.4	7.6
15	Protective foods are fruits, sea foods, calcium, iron, salts and vegetables.	92.4	7.6
16	Water is a necessary nutrient.	100.0	0.0
17	Water helps in easy food digestion.	100.0	0.0
18	Water prevents indigestion.	60.0	40.0
19	Good nutrition involves eating a variety of food in the right proportion.	63.8	36.2

$$\bar{x} = \frac{\sum x}{19} = 69.2, \quad \bar{x} = \frac{\sum x}{19} = 30.8$$

Reliability of the instrument

The reliability of the instrument was established with data from 30 students with a similar background who did not participate in the study. Using a split-half data the reliability co-efficient of 0.74 was obtained by Kuder Richardson Formula 21 statistic. The reliability index was considered adequate and suitable for data collection in the study.

Method of data collection

With the consent of the principals of each of the schools drawn, as well as the respondents themselves, the researchers personally administered copies of the questionnaire to the respondents with the assistance of three duly trained research assistants. Copies of the questionnaire were retrieved upon administration to ensure quick and high return rate.

Method of data analysis

Descriptive statistics (percentages) and t-test were used for data analysis. The null hypotheses were tested at .05 alpha levels. To categorize the score as low, moderate or high, a modified Ashur (1977) principle was used, thus: below 40% - low, 41 to 60% - moderate, and 61% and above – high.

RESULTS

The data in Table 1 shows variations in the responses of students on their level of knowledge of nutritional values with respect to the individual items. A mean score of 69.2% was recorded for correct responses, while 30.8% was recorded for incorrect responses. The findings indicate that students were generally knowledgeable in view of very high positive scores recorded for most items in the list of variables.

The data in Table 3 revealed that the calculated t-value (t_{cal} = 3.51) was greater than the table value (t_{cri} = 1.96) at 419 df and .05 alpha level; the null hypothesis is therefore rejected. Thus, knowledge of nutritional value has statistically significant influence on nutritional behaviour of students. The data in Table 4 shows the χ–square analysis of influence of family income on students' nutritional habit. Since the computed χ-value (7.3) is greater that the χ_{cri} (5.99), the null hypothesis was rejected. This implies that family income has significant influence on nutritional habit of the students. Moreover, the data in Table 5 shows the χ-square analysis of influence of gender on nutritional behaviour with a higher calculated value of 53.46 and χ-critical of 3.84. Thus, the null hypothesis was rejected, meaning that gender has a statistically significant influence on nutritional behaviour. The findings obtained could be summarised thus:

(1) As shown in Table 1, most of the respondents had a high level of knowledge of nutritional values as indicated by the high positive (correct) scores on most parameters

Table 2. percentage analysis of nutritional behaviour of secondary school students.

S/N	Items	Responses (%)	
		Agree	Disagree
1	I do take snacks even if I have taken enough foods	36.7	36.3
2	I prefer to be late to school than to forgo my breakfast everyday	32.4	67.6
3	I eat once a day to check weight	23.3	76.7
4	I prefer light foods thrice a day provided it is balanced	72.4	27.6
5	I eat between meals in addition to snacks	95.2	4.8
6	When food is given in school, I do not eat much because I want to read	71.2	28.8
7	I do not eat late in the evening to ensure adequate digestion before morning	68.8	31.2
8	I eat a lot of fruits before meal in the morning in order to have appetite	66.9	33.1
9	I prefer heavy meal in the morning	91.4	8.6
10	I prefer natural food substances to artificial foods especially tin foods	97.9	2.1
11	I prefer heavy food after school not minding the food nutrients	82.9	17.1
12	When I am given enough money, I eat everything that is available	90.0	10.0
13	I eat heavy meals two times a day instead of taking three meals	47.4	52.6
14	I take only available foods so long as I cannot mind the nutritional value	63.8	36.2
15	I prefer white soup to vegetable soup	59.2	40.4
16	Instead of eating diets containing vitamins and minerals, I depend on mineral and vitamins supplements	23.3	76.7
17	My parents do not like taking fruits and I behave same by avoiding fruits	17.1	82.9
18	I drink soft drinks instead of taking enough water after meal	66.9	33.1

$$\bar{x} = \frac{\sum x}{19} = 61.5; \quad \bar{x} = \frac{\sum x}{19} = 38.5$$

Table 3. t-Test analysis of influence of knowledge of nutritional value on nutritional behaviour (n = 420).

Variable	$\bar{X}$	SD	t_{cal}	t_{cri}
Knowledge of nutritional value	61.8	7.6	3.5*	1.96
Nutritional behaviour	63.4	9.6		

P < .05, df = 419, * = Significant

Table 4. X–Square analysis of the influence of family income on nutritional behaviour.

Family monthly income	Responses		Total	r^2
	Agreed	Disagreed		
₦10, 000.00 – ₦ 30, 000.00	194 (187.1)	68 (74.8)	262	7.3*
₦ 31,000.00 – ₦ 50,000.00	46 (88.6)	46 (35.4)	124	
₦ 51,000.00 and above	28 (24.3)	6 (9.7)	34	

*significant; P ≤ .05; χ_{cri} = 5.99, and 2 df. Figures in parentheses are expected frequencies.

used to assess knowledge of nutritional values. A mean score of 69.2% was recorded for correct responses, while 30.8% was recorded for incorrect responses.

(2) Knowledge of nutritional value has statistically significant influence on nutritional behaviour of students. The data in Table 3 revealed that the calculated t-value (t_{cal} = 3.51) was greater than the table value (t_{cri} = 1.96) at 419 df and .05 alpha level. Thus, the null hypothesis was rejected.

(3) Family income has a significant influence on students'

Table 5. χ –Square analysis of the influence of gender on nutritional behaviour.

Variables	Responses		Total	χ
	Agreed	Disagreed		
Male	136 (167.3)	79 (47.6)	215	53.46*
Female	191 (159.6)	14 (45.4)	206	
Total	327	93	420	

nutritional habit. This is shown in Table 4 that the calculated χ-value (7.3) was greater than the χ_{cri} value (5.99); the null hypothesis was thus rejected.

(4) The data in Table 5 showed a higher calculated χ-square value of 53.46 than the critical value of 3.84 at .05 alpha levels on the influence on gender and students' nutritional behaviour. This implies that there was a statistically significant influence of gender on nutritional behaviour. Consequently, the null hypothesis was rejected.

DISCUSSION

Findings in Table 1 on knowledge of nutritional values revealed some variations in the responses on knowledge of food values. For instance, all the respondents accepted that nutrition is needed for growth and that water is needed for digestion. Also, 97.9% identified correctly the major sources of protein, while 92.4% indicated correctly too that protective foods are needed for development of bones. Only 24.5% were able to indicate correctly the sources of energy giving foods. Also, 90.0% accepted that fatty foods help in regulating body heat, while 66.9% could identify the sources of nutrients needed for normal body functioning.

An average score of 69.19% was recorded generally for all the correct responses on knowledge. This tends to suggest that more than half of the respondents had a substantial level of knowledge with respect to food values. This score is an indicator for successes in nutrition education in the area. The score was slightly higher than the result (54.2%) of Waterlow (1998) on determining students' nutritional knowledge in Karba Local Government Area of Kogi State, Nigeria. The findings indicated that students were generally knowledgeable in view of very high scores recorded for most items in the list of variables. This, however, does not becloud the need for intensive nutrition education in schools as well as in the community considering the fact that only SSII students were involved in the study. It is possible that students in lower classes may not record similar findings. Intensive health education is still indicative in view of Ikorok (2001b) assertion of strong relationship between nutritional knowledge and nutrition education in all cultures.

Similarly, the data in Table 2 predictably showed a corresponding high positive response with respect to nutritional behaviour. The findings indicated that on the average, 61.5% of the respondents exercised appropriate nutritional behaviour for health promotion. Further findings showed that students' knowledge of nutritional values has a statistically significant influence on their nutritional behaviour (t_{cal} = 3.51, t_{cri} = 1.96 at 419 df and 0.05 alpha level). These findings were in congruence with the findings of Okoro (1991) in the study to determine nutritional knowledge and practice of women in Owerri Urban. The result also corroborates findings of a similar study by Ikorok and Udondata (2005) on child care practices of mothers in Akwa Ibom State. Based on the results of these findings, it could be inferred that there is hope for successes and sustainability of nutrition education programmes in the area.

However, these findings contrast that of Rita (2000) which aimed at determining mother's nutritional knowledge in India, whereby only 10%of mothers could identify correctly the age to introduce weaning diet to the babies. The findings are also in line with that of Ikorok and Ekpenyong (2005) in their study on child nutritional practices of nursing mothers in Akwa Ibom State. It is possible that the increase knowledge of students in this study is as a result of the use of a formally planned educational curriculum for programmed instruction within the formal setting of the school environment. It is, therefore, necessary that health educators should endeavour to consciously plan their instructional programmes. These again suggest that use of a planned and consistent programme of instruction for health education is effective and should be adopted for community-wide nutrition education programmes.

The result in Table 4 that family income has influence on nutritional behaviour was not a surprise due to several experts' assertion on such relationship. Okoro (1991) and Ekpenyong (1998) in their studies indicated that family knowledge and income level determine food choices, quantity and quality of food consumed. The implication is that level income in turn influences children food choices and eating pattern even in school. Since almost all of the schools selected were day schools, the students depended essentially on whatever was available to them in the family. Further findings in Table 5 on gender and nutritional behaviour produced similar responses. Female students indicated more positive nutritional behaviour than their male counterparts. This result may have been

influenced by the availability of females in this culture with respect to food production and processing activities as assigned by their gender role.

The inference from findings of this study also corroborates findings of similar studies (Ikorok, 2001; Ikorok and Udondata, 2005) that social and cultural factors exert much influence on behaviour. These factors, therefore, should be considered in all health education interventions. Inference from findings could be used further to validate the global trends towards the paradigm shift from concentration on the medical model in health promotion to the more inclusive approach that also considers social indicators as paramount determinants of health, injury, and disability (WHO, 2000). The shift also assures reduction in health inequalities by targeting changing determinants of health in contemporary society. This implies that health care interventions should address economic and social behavioural indicators. In the United Kingdom, for instance, the Acheson Review highlighted the importance of socio-economic determinants of health inequalities and identified a range of social and welfare policies to promote the well-being of the population. Food consumption pattern is a cultural phenomenon; therefore, nutrition education and similar health interventions in our communities should be based on culturally-oriented processes if significant changes are anticipated.

CONCLUSION AND RECOMMENDATION

Findings of the study revealed the followings:

(i) A high positive average score of 69.2%, indicating that students possessed high knowledge of nutritional values.
(ii) A high positive average score of 61.5%, indicating that respondents exercised appropriate nutritional behaviour for health promotion in Akwa Ibom State.
(iii) That knowledge of nutritional values has a statistically significant influence on nutritional behaviour of secondary school students in Akwa Ibom State (t_{cal} = 3.51 t_{cri} = 1.96 at 419 df and 0.05 alpha level).
(iv) Also, family income has a statistically significant influence on nutritional behaviour of students (calculated χ-value = 7.3, $\chi_{cri,}$ value = 5.99).
(v) Finally, gender had a significant influence of nutrition behaviour of secondary school students in the state (calculated χ-square value = 53.46, critical χ –square value = 3.84 at .05 alpha levels).

Based on the findings, it was recommended that planned and consistent programme of instruction for nutrition education should be undertaken to sustain and improve the level of knowledge and nutrition behaviour of students in the state. Also, nutritional behaviour being a cultural phenomenon implies that interventions to improve nutritional behaviour of people should adopt culturally-oriented approaches for sustainability. Finally, in view of the economic determinants of nutritional behaviour, government should formulate policies that will improve the social and economic status of people, while intensifying the poverty reduction programmes at the various levels.

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Full Length Research Paper

Study on changes of nutritional and organoleptic quality of flavored candy prepared from aonla (*Emblica officinalis* G.) during storage

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Aonla is an important crop indigenous to Indian subcontinent which is used in alternative medicine, health foods and herbal products. It has got great potential in processed forms but little information is available regarding the dehydration and storage quality of aonla. The aonla fruits of each cultivar (Krishna, NA-7, NA-10 and Chakkaiya) were washed and blanched in boiling water containing 2% alum for 8 to 10 min. The segments were separated after cooling the fruits in tap water. The segments were stepped for 24 h in successively increasing concentration of sugar syrup (50 to 70^{0}B); added flavors of ginger and cardamom in syrup having 70^{0}B for three days. The excess syrup drained out and the segments were dried in cabinet drier. The segments were packed and stored under ambient conditions. The nine months storage study revealed that the moisture content in the candy was found to decrease with storage. It decreases from an initial value of about 16% to a final value of about 14% at the end of storage. All the treatments reduced vitamin C content candy. The tannin content of the various aonla candies was statistically significant with respect to aonla varieties. Total soluble solids, acidity, total reducing and browning was found to increase with storage period, while the non reducing sugar was decreased with storage period. On the basis of organoleptic evaluation and biochemical characters concluded that the candy prepared from cv. Krishna and flavored with cardamom powder found to be the best aonla candy.

Key words: Aonla, dehydration, drying, blanching, candy.

INTRODUCTION

Fruits are amongst the first food items known consumed prehistorically by human beings. Fruits, whether fresh or dried, have always formed a part of the staple diet of human beings because they are rich in nutrients and provide some of the essential minerals, vitamins, and the like, apart from that, they also help in curing a number of diseases. Aonla, among fruits commonly known as Indian Gooseberry (*Emblicaofficinalis.* Gaertn syn. *Phyllanthus emblica* L.) finds a special place in India as it has got tremendous medicinal values. It belongs to the family Euphorbiaceae and comprises about 350 (Hooker, 1973) to 500 species (Baileri, 1917). Aonla has been cultivated in India since time immemorial (Singh et al., 2009). Besides India, naturally growing aonla trees are also found in different parts of the world, *viz*. Sri Lanka, Cuba, Puerto Rico, China, Thailand and Japan. Aonla is a rare example of an edible material, which is rich in tannins as well as ascorbic acid (Kalra, 1988). The vitamin C content in aonla varies from 200-900 mg /100 g depending upon the variety and size of the fruit (Anonymous, 1988; Barthakur and Arnold, 1991).

Aonla is presently an underutilized fruit, but has enormous potential in the world market. It is almost

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Table 1. Physical characteristics of different aonla cultivars.

Cultivars	Weight (g)	Stone (%)	Fiber (%)	Moisture (%)
Krishna	44.7	4.90	1.90	83.4
NA-7	48.1	4.30	1.10	84.7
NA-10	44.8	5.13	1.30	84.5
Chakaiya	30.7	4.20	2.00	85.6

entirely unknown in the world market and needs to be popularized. Aonla is being exported under the category of Ayurvedic and Unani herbs. Its medicinal and nutritional properties and culinary uses need to be highlighted. The fresh fruits are generally not consumed as it is highly acidic and astringent; therefore it is not a popular table fruit. But, it has got great potential in processed forms (Nayak et al., 2011). Hence attention has been focused on the preparation of different value added products from aonla. Aonla can be made into various products such as pickles, preserve (murabba), sauce, jam, jelly, dried chips, tablets, etc.

Aonla candies are becoming more and more popular because of high acceptability, minimum volume, higher nutritionally value and longer storage life. These have additional advantage of being least thirst provoking and ready to eat snacks. The dried products save energy, money and space in packaging, storage and transportation. Plain aonla candies have now been fused with other richly valuable and effective herbs like tulsi, mint etc. Herbal inclusion not only gives a new flavor but also enriched the candy with more medicinal qualities. In present investigation an attempt has been made to evaluate a product, aonla candies, prepared from fruits of different aonla cultivars and flavored with different herbs.

MATERIALS AND METHODS

Mature aonla fruits of cultivars Krishna, NA-10, NA-7 and Chakaiya were procured from the experimental farm of Central Institute for Subtropical Horticulture, Lucknow, India. Matured, uniform sized and disease free fruits of each variety were selected. Fruits were washed in running water to remove adherent dirt (Figure 1).

Ginger

Fresh ginger rhizomes were washed thoroughly in running water and peeled manually. They were then grated using grater and dried in the sun for 3 to 4 days until the ginger was fully dried and then powdered using a grinder.

Cardamom

Pods of green cardamom (*Elettaria subulatum*) were opened and the seeds collected and grated. The biochemical parameters, *viz*. total soluble solids (TSS), acidity, vitamin-C, tannin, total sugar, reducing sugar, non-reducing sugar were estimated in fruits and the product, however non-enzymatic browning was estimated only in the product (Ranganna, 1997). The product was also assessed organoleptically on the 9 point Hedonic scale as described by Ranganna, (1997). The data were analyzed statistically and reported at the 5% significance level (Panse and Sukhatme, 1961).

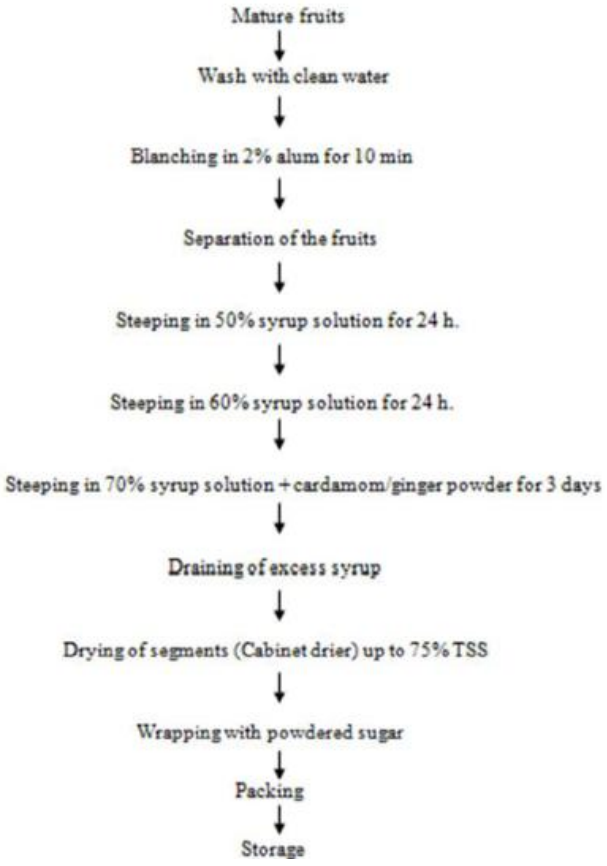

Figure 1. Flow chart for preparation of Aonla candy.

RESULTS

The physical characters of the fresh aonla fruits clearly indicate that there were significant differences between the aonla cultivars in terms of physical and biochemical characters (Table 1). Average weight of fruit varied from 30.7 to 48.1 g. The maximum average fruit weight was recorded in cv. NA-7 (48.1 g), while the minimum fruit weight was recorded in cv. Chakaiya (30.7 g). The stone percentage varied from 4.20 to 5.13%. The fibre content

Table 2. Chemical characters of fresh fruits of different aonla cultivars.

Cultivars/Characters	TSS (^{O}Bx)	Titratable acidity (%)	Ascorbic acid (mg/100 g)	Tannins (%)	Total sugars (%)	Reducing sugars (%)	Non-reducing sugars	Non-enzymatic browning
Krishna	11.0	1.5	339	1.54	9.1	1.7	1.7	0.03
NA-7	9.3	1.7	238	1.81	6.8	1.5	1.4	0.04
NA-10	9.5	1.8	285	1.80	6.8	1.6	1.4	0.04
Chakaiya	9.7	1.7	309	1.73	7.4	1.6	1.4	0.03
CD at 5%	0.63	0.17	1.7	0.06	0.17	0.17	0.006	NS

Table 3. Effect of aonla cultivars and flavor on moisture content (%) of aonla candy during storage.

Cultivars	Flavors	Storage period (days)			
		0	90	180	270
Krishna	Cardamom	16.85	16.40	15.65	14.95
	Ginger	16.75	16.05	15.35	14.80
NA-7	Cardamom	16.55	16.15	15.70	15.20
	Ginger	16.85	16.40	15.70	14.95
NA-10	Cardamom	16.60	15.90	15.30	14.80
	Ginger	16.90	16.25	15.65	15.10
Chakaiya	Cardamom	16.75	16.10	15.60	14.75
	Ginger	16.65	16.15	15.60	15.20
CD (5%)		NS	NS	NS	NS

of fruits ranged between 1.10 to 2.00%. The highest fibre content was recorded in cv. Chakaiya (2.0%) and the lowest in cv. NA-7 (1.1%). The moisture content of aonla cultivars differed significantly, and ranged from 83.4 (cv. Krishna) to 85.6% (cv. Chakaiya). The data of biochemical characters for fresh fruits are shown in the Table 2. The total soluble solids (TSS) content of fresh fruits ranged from 9.3 to 11.0^{O}Bx. Cultivar Krishna showed maximum TSS content (11.0^{O}Bx), which was significantly higher compared to other cultivars. The minimum TSS content was obtained in cv. NA-7 (9.3^{O}Bx). A significant variation in acidity was also observed in different cultivars of aonla. Acidity in fresh fruit ranged from 1.5 to 1.8%. Fresh fruits of cv. Krishna recorded maximum vitamin C (339 mg/100 g), while the minimum was recorded in cv. NA-7 (238 mg/100 g). The tannin content in all the fruits differed significantly and ranged from 1.54 to 1.81% in fresh aonla fruits. The highest total sugar (9.1%) was observed in fresh fruits of cv. Krishna, while lowest (6.8%) in cv. NA-7 and NA-10. The highest reducing sugar content was recorded in fresh (1.7%) as well as blanched fruits (1.4%) of cv. Krishna, while lowest in fresh fruits of cv. NA-7 (1.5%). The non-reducing sugar in all the cultivars differed significantly, and ranged from 1.4 to 1.7%.

Changes in biochemical characters during storage of the product

The moisture content of various aonla candies prepared from different aonla cultivars was recorded during storage as shown in Table 3. The data revealed that the moisture contents of the various aonla candies were statistically nonsignificant with respect to aonla varieties. The moisture content decreased with an increase in storage period. After 270 days of storage, the moisture content decreased from an intial range of 16.5 to 17.2% to a final of 14.7 to 15.4%.

The organoleptic evaluation of the product was assessed on the basis of color, appearance, texture and taste and the overall average (Table 6). Generally, a decrease in the quality of the product was recorded during storage. However, in some treatments a slight improvement in quality was observed after storage. The product from all the treatments was acceptable even after

270 days of storage. In the beginning, the product from cv. Krishna flavored with cardamom scored highest (8.3), while product from cv. NA-10 scored lowest (7.3). An improvement in organoleptic quality (average score) was noticed in the candy prepared from cv. Chakaiya flavoredwith cardamom during storage. However, the overall organoleptic quality of the product prepared from cv. Krishna (cardamom) was the best throughout the storage period followed by candy from cv. Krishna (ginger) and cv. Chakaiya (cardamom).

DISCUSSION

The average weight of aonla fruit harvested in this investigation varied from 30.7 to 48.1 g. Ghorai and Sethi (1996) recorded an average fruit weight of 43.5 g for cv. Krishna. Singh and Pathak (1987) mentioned an average fruit weight of 38.2 g. Singh et al. (2004) recorded maximum fruit weight in cv. NA-10. The difference in average fruit weight might be due to varietal characteristics and agro-climatic conditions in which they are growing. The stone percentage varied from 4.20 to 5.13 and its content was lowest in cv. Chakaiya (4.20%). Singh et al. (2005) reported maximum seed weight in cv. Krishna. The lowest fibre content in present investigation was recorded in cv. NA-7 (1.1%) and highest in cv. Chakaiya (2.0%). Teaotia et al. (1968) reported that the fibre intensity varied from slightly fibrous to highly fibrous and little variation existed in stone percentage of aonla cultivars. Sharma et al. (1989) observed 3 to 4% fibre in aonla fruits, which seemed to be the highest value reported in literature. Singh et al. (2004) have reported that cv. Chakaiya has the highest (1.93%) fibre content which is consistent with our results. The moisture content of aonla cultivars ranged from 83.4 to 85.6%. Pathak et al. (2003) reported that moisture content ranged from 85.2 to 87.7% in various aonla cultivars. A variability in physical composition of aonla cultivars have also been reported by many other workers (Pathak, 1988; Sharma et al., 1989; Deen, 1992), which might possibly be due to differences in genetic characters of cultivars, soil, cultural practices and climatic conditions.

The chemical composition recorded in different cultivars of aonla varied significantly (Table 4). The total soluble solids (TSS) content of fresh fruits ranged from 9.3 to 11.0ºBx, whereas cv. Krishna showed maximum TSS in fresh fruits followed by cv. Chakaiya. The TSS content of aonla fruits varied widely depending on the variety and climatic conditions. Therefore, different aonla cultivars harvested at full maturity differ significantly in TSS content. Variability of TSS content in aonla cultivars was also reported by (Sharma et al., 1989; Deen, 1992; Singh, 1999). Our findings are relatively close to those of Singh and Pathak (1987), who reported 10.7 and 10.2% TSS in fresh fruits of Krishna and Chakaiya cultivars, respectively. Similarly, Singh et al. (2004) reported TSS content of 9.4% in cv. Chakaiya, while Singh and Arora (1967) reported slightly higher TSS (10.9%) in cv. Chakaiya. In present study, differences in the content of titratable acidity were also observed in different aonla cultivars. Titratable acidity in fresh fruits ranged from 1.5 to 1.8%. Organic acids are responsible for sourness of fruits. Variability in titratable acidity was also reported by Singh (1997). The data recorded on titratable acidity of cvs Chakaiya and Krishna in present study is in close conformity to the findings of Singh and Pathak (1987), who observed 1.5 and 1.2% titratable acidity in Chakaiya and Krishna cultivars of aonla, respectively. Pathak (1988); Singh and Singh (1994) have reported higher values for titratable acidity than the present findings which might be due to variation in agro-climatic conditions or stage of harvest. Fresh fruits of cv. Krishna recorded maximum ascorbic acid content (339 mg/100 g) followed by cv. Chakaiya (309 mg/100 g). Ascorbic acid plays an important role in human nutrition and due to this reason aonla fruits are preferred by the community not only as a table fruit but in a processed form too. In aonla cultivars, ascorbic acid content varies from place to place and variety to variety. The ascorbic acid content in aonla fruits grown world-wide ranged from 200 to 1800 mg/100 g of fruit pulp (Ram, 1983). Singh (1982) have reported 500 to 750 mg/100 g ascorbic acid in different aonla cultivars. Meghwal and Azam (2004) have reported highest ascorbic acid content in cv. Krishna which supports our findings. The differences in ascorbic acid content of fruits in present study and those reported in literature may be attributed to various factors including agro-climatic conditions in which fruits are grown and the maturity of fruits. The tannins content ranged between 1.54 to 1.8% in fresh fruits. The minimum content of tannins was found in cv. Krishna followed by cv. Chakaiya. Aonla is a rare example of fruits which is rich in tannins. Variability in the content of tannins was also reported by Jain et al. (1983); Srivastava and Kumar, (1994). Our findings are in close conformity to those of Mehta et al. (2005), who reported 1.51 and 1.40% tannins in cvs Krishna and Chakaiya, respectively. The total and reducing sugars recorded in fresh fruits ranged from 6.8 to 9.1 and 1.5 to 1.7%, respectively. The total and reducing sugars were most abundant in cv. Krishna followed by cv. Chakaiya in fresh fruits. Taeotia (1968) has reported 7 to 9% total sugars and 1 to 4% reducing sugars in various cultivars of aonla. Singh et al. (1993) observed a slight higher value of reducing sugars in different aonla cultivars and lower values for total sugars, while Mehta et al. (2005), recorded higher values for total and reducing sugars as compared to data obtained in the present study. This might be due to variation in climatic conditions, maturity stage and varietals characteristics.

The moisture content of the various aonla candies was statistically non-significant with respect to aonla varieties. The moisture content here was also found to decrease with an increase in storage period. The decrease in

Table 4. Effect of aonla cultivars and flavors on biochemical characters of prepared candy during storage.

Cultivars/ Characters	Flavors	TSS (°Bx)				Acidity (%)				Vitamin C (mg/100 g)				Tannin (%)			
		Storage period (days)				Storage period (days)				Storage period (days)				Storage period (days)			
		0	90	180	270	0	90	180	270	0	90	180	270	0	90	180	270
Krishna	Cardamom	75.2	75.9	77.3	130.4	0.48	0.51	0.55	0.62	132.8	102.0	83.8	57.0	0.22	0.21	0.18	0.17
	Ginger	75.2	75.8	77.4	132.8	0.49	0.50	0.56	0.63	130.4	99.4	83.8	55.7	0.22	0.20	0.19	0.17
NA-7	Cardamom	75.2	76.2	78.0	115.4	0.49	0.52	0.58	0.66	115.4	94.5	73.2	47.3	0.23	0.21	0.20	0.18
	Ginger	75.1	76.0	77.7	114.0	0.52	0.55	0.61	0.69	114.0	95.2	74.0	47.2	0.24	0.22	0.19	0.17
NA-10	Cardamom	75.1	75.8	76.7	104.9	0.55	0.56	0.62	0.75	104.9	90.5	68.7	43.7	0.22	0.20	0.18	0.17
	Ginger	75.1	75.8	76.8	106.6	0.56	0.59	0.66	0.74	106.6	88.8	66.8	44.1	0.22	0.20	0.18	0.17
Chakaiya	Cardamom	75.2	75.7	77.2	127.3	0.50	0.54	0.63	0.68	127.3	96.5	77.7	52.8	0.22	0.21	0.19	0.18
	Ginger	75.2	75.8	77.1	126.2	0.53	0.57	0.64	0.71	126.2	100.1	66.2	52.2	0.24	0.22	0.20	0.19
CD (5%)		-	0.005	0.14	0.11	0.012	0.014	0.016	0.014	2.66	0.76	1.84	0.96	0.005	0.003	0.002	0.002

Table 5. Effect of aonla cultivars and flavors on biochemical characters of prepared candy during storage.

Cultivars/ characters	Flavors	Total sugar (%)				Reducing sugar (%)				Non-reducing sugar (%)				Non-enzymatic browning (OD at 440 nm)			
		Storage period (days)				Storage period (days)				Storage period (days)				Storage period (days)			
		0	90	180	270	0	90	180	270	0	90	180	270	0	90	180	270
Krishna	Cardamom	66.6	65.8	68.1	68.2	38.1	40.0	42.2	44.3	28.5	27.2	26.0	25.3	0.04	0.11	0.14	0.16
	Ginger	66.4	65.6	67.7	69.1	37.5	38.7	42.0	44.2	28.3	27.7	25.4	25.1	0.05	0.12	0.15	0.17
NA-7	Cardamom	66.5	66.4	68.1	69.5	36.5	37.6	40.4	43.0	27.8	27.4	26.9	25.4	0.04	0.10	0.13	0.15
	Ginger	66.5	66.4	68.1	69.8	37.2	39.1	41.3	43.5	28.4	27.5	26.4	25.1	0.05	0.12	0.15	0.17
NA-10	Cardamom	64.9	64.2	66.2	67.4	35.0	36.5	37.1	39.5	29.2	28.9	28.1	27.5	0.05	0.12	0.14	0.16
	Ginger	64.3	63.8	66.4	67.5	35.5	36.8	38.2	40.4	29.1	28.6	28.2	27.1	0.05	0.13	0.15	0.18
Chakaiya	Cardamom	65.1	64.2	66.5	67.8	36.1	37.8	40.1	42.3	28.2	27.3	26.1	25..2	0.04	0.10	0.13	0.16
	Ginger	64.5	64.0	66.5	67.6	36.6	38.4	40.8	42.8	28.3	27.4	25.9	25.1	0.05	0.12	0.15	0.17
CD (5%)		NS	NS	NS	NS	NS	NS	NS	NS	0.26	0.24	0.38	0.40	NS	NS	NS	NS

Table 6. Effect of aonla cultivars and flavors on sensory quality of prepared candy during storage.

Cultivars/ characters	Flavors	Color				Appearance				Texture				Taste				Overall average (Out of 9)			
		Storage period (days)				Storage period (days)				Storage period (days)				Storage period (days)				Storage period (days)			
		0	90	180	270	0	90	180	270	0	90	180	270	0	90	180	270	0	90	180	270
Krishna	Cardamom	8.6	8.2	8.0	7.8	8.2	8.0	8.8	8.8	8.2	8.0	8.8	8.8	8.4	8.2	8.4	8.4	8.3	8.1	8.5	8.2
	Ginger	8.0	7.8	6.8	7.0	7.8	7.6	7.4	7.2	7.8	7.0	7.8	8.2	7.6	7.2	7.3	7.1	7.8	7.2	7.4	7.6
NA-7	Cardamom	7.5	7.5	7.8	6.8	7.7	7.0	7.2	7.0	8.2	6.8	7.0	6.8	7.8	7.1	6.8	6.6	7.8	7.1	7.2	6.8
	Ginger	7.5	7.0	7.0	6.3	7.5	7.0	7.0	6.8	7.8	7.0	7.0	6.8	7.2	6.6	6.6	6.1	7.5	6.9	6.9	6.5
NA-10	Cardamom	7.7	7.0	7.2	7.0	7.5	7.5	7.8	6.8	7.5	7.0	7.0	6.3	7.6	7.0	6.8	6.4	7.5	7.1	7.2	6.6
	Ginger	7.5	7.0	7.0	6.8	7.2	6.6	6.6	6.1	7.4	7.0	7.0	6.1	7.4	6.8	6.4	5.8	7.3	6.8	6.7	6.2
Chakaiya	Cardamom	8.0	7.8	7.2	7.0	7.8	7.6	7.4	7.2	7.6	6.8	8.0	8.4	7.8	7.0	7.8	8.2	7.8	7.2	7.4	7.6
	Ginger	7.8	7.6	7.4	7.2	7.5	7.5	7.8	6.8	7.8	7.0	7.0	6.8	7.8	7.1	6.8	6.6	7.7	7.3	7.2	6.8
CD (5%)		0.05	0.07	0.09	0.05	0.05	0.05	0.03	0.04	0.04	0.05	0.07	0.06	0.05	0.04	0.04	0.05	0.07	0.06	0.05	0.04

moisture content in the various aonla candies with an increase in storage period might be due to the evaporation of moisture from the product. Decrease in moisture with storage of candies were also reported by Tripathi et al. (1988) in aonla candy, Mehta et al. (2005) in galgal peel candy and Rani and Bhatia (1985) in pear candy.

TSS gradually increases with increase in storage period. This might be due to conversion of polysaccharides into sugars during hydrolysis process. Increase in TSS might also be attributed to the reduction in moisture content of the product with storage. Increase in TSS with storage was also found to be reported by Tandon et al. (2003); Tripathi et al. (1988); Kumar and Singh (2001) in aonla candy, Manivasagan et al. (2006) in karonda candy and Rani and Bhatia (1985) in pear candy. Acidity content did not change in the beginning of storage, thereafter it increased during storage. Pectic acid has been reported to increase the acidity in fruit products, hence, degradation of pectic substances into soluble solids might have contributed towards an increased in acidity of aonla products. An increase in acidity with storage period has also been observed in aonla preserve. Similar findings were also observed by Sethi (1980); Kumar and Singh (2001) in aonla products. These results were contrary to the results obtained by Rani and Bhatia (1985); Tripathi et al. (1988) in which the acidity decreases with storage. The ascorbic acid content of the products decreased continuously during storage.

Reduction in vitamin 'C' could be due to oxidation by trapped oxygen in the jars which results in formation of dehydroascorbic acid. Loss in ascorbic acid content was also observed by Sethi (1980) in aonla preserve, Tripathi et al. (1988) in aonla products, Rani and Bhatia (1985) in pear candy and Kumar and Singh (2001) in aonla products. Decrease in ascorbic acid content might be attributed to the increase in Tannin. Decrease in tannin content was also reported by Mehta and Tomar (1979); Jain et al. (1983); Tandon et al. (2003). The total sugars, reducing sugars and NEB (non-enzymatic browning) increased gradually in candy during storage, while non-reducing sugar and sensory quality decreased in the product prepared from all the varieties flavored with different herbs.

On the basis of the observations recorded on various biochemical characters and organoleptic quality, it is clear that cv. Krishna and cardamom flavor is most suitable for the preparation of quality product candy. Cultivar Chakaiya could also be used for product preparation. Hence, a processed product of good quality could be made only from good quality raw material. The cultivar selection is one of the most important factors for preparation of a quality product. Thus, the cultivar

evaluated showed great potential for becoming a commercial cultivar of processing industry.

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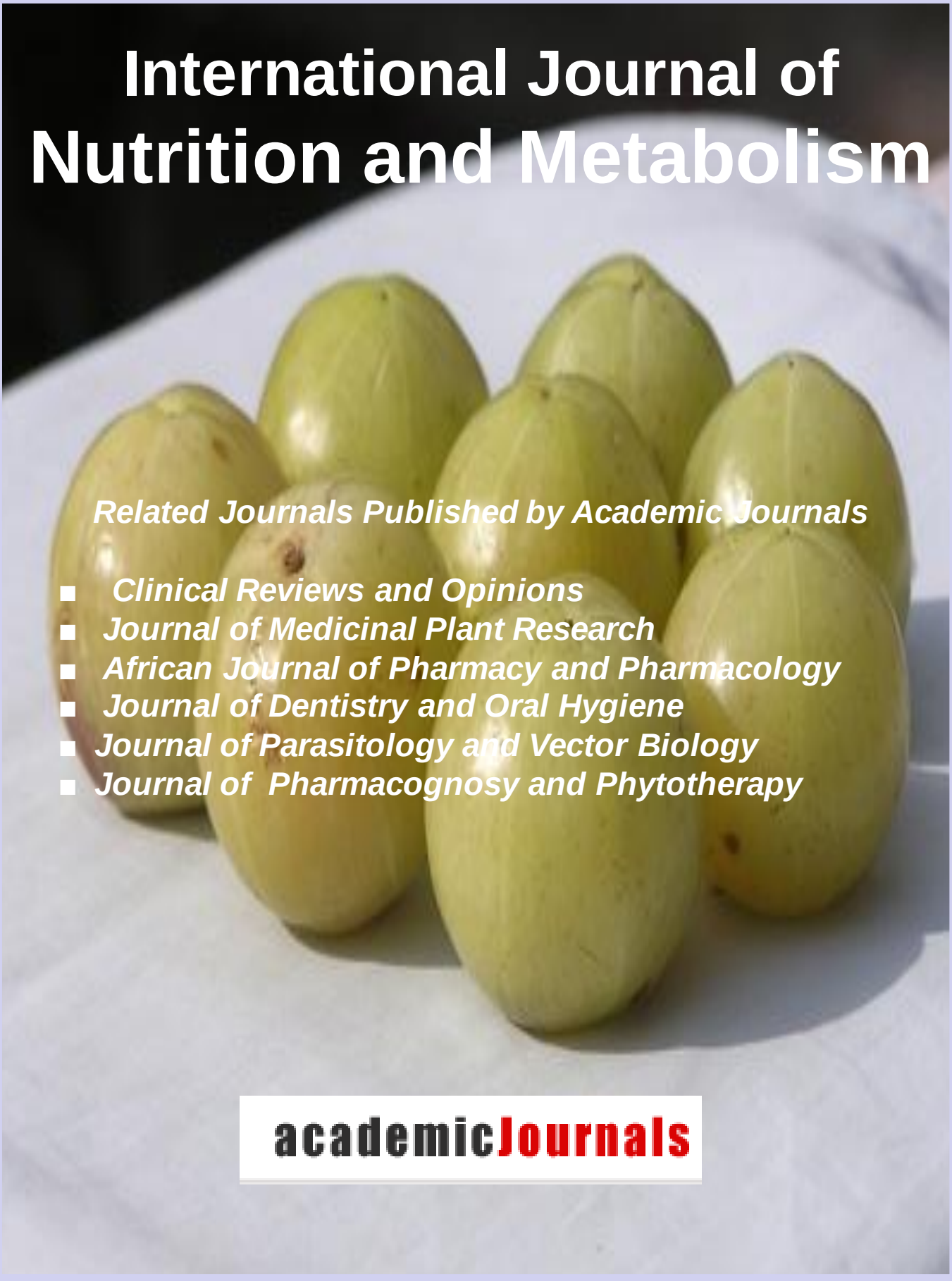

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