PJN

NPAKISTAN JOURNAL OF
UTRITION

Effect of the Antioxidant Drinks Intervention on Immunoglobulin G in Adults Obesity

Siti Ika Fitrasyah, Cesilia Meti Dwiriani and Lilik Kustiyah
Department of Community Nutrition, Faculty of Human Ecology,
Bogor Agricultural University, Bogor-16680, Indonesia

Abstract: Oxidative stress can lead to infection, which in turn have effects on the onset of the diseases. Particularly in adults obesity who have low immune response which is characterized by an increase in lymphocytes levels that play a role in producing immunoglobulin G (IgG) antibody to fight infection in the body. The purpose of the study was to analyze effect of antioxidant drinks intervention (tomato extracts and flavoured-rice bran powder drinks) on titers of IgG in adults obesity used quasi-experimental one group pre and post-test design. The subjects used in this study were 13 adults. The intervention 240 ml (2 cups) of tomato extracts and 30 g (2 sachets) of flavored-rice bran powder of each 1 to 2 times a day for 2 weeks (14 days). Results showed a significant decreased in IgG titers and proved that the intervention antioxidant drinks able to give effect to the improvement of the subjects's body immunity by improving the body's oxidative stress level.

Key words: Adults, antioxidant drinks, immunoglobulin G, obesity

INTRODUCTION
Previously, image of obesity be a sign of well-being, prosperity and fertility associated with a person's socioeconomic status, so that people were trying to become obesity. However, as the development of knowledge, it be the scourge especially adults who can be seen from the prevalence increased from year to year. Based on Riskesdas in 2007 and 2013, within a period of 6 years the prevalence of obesity in is, respectively 9.6% increase to 15.4%. In West Java, from 2007 to 2010 was also an increase in the prevalence of obesity from 11.1 to 11.4% with a relatively higher prevalence in civil servants/employees of 16.5% in 2010 (Balitbangkes, 2008, 2010).

It is well known, obesity can increase the risk of disease that can lead to chronic inflammation of adipose tissue and macrophages (Wellen and Hotamisligil, 2005). Chronic inflammation that occurs continuously can lead to oxidative stress due to low levels of antioxidants in the human body (Cunningham-Rundles, 1993). Oxidative stress, especially in obesity people can affect the immune response. Low immune responses in obesity people is characterized by increase of adipose tissue's size and amounts (Aeberli *et al.*, 2006), formation of free radicals associated with increase of inflammatory cytokines (Furukawa *et al.*, 2004) and ROS's (Reactive Oxygen Species) level (Hajer *et al.*, 2008), increase of macrophage's level (Otto and Lane, 2005; Hajer *et al.*, 2008), increase of TNF-α's level and increase of T and B lymphocytes's level (Boynton *et al.*, 2007). Specific immune system (T and B lymphocytes)

play a role in producing IgG antibodies that attack the invading microbes and adipose tissue macrophages (Baratawidjaja and Rengganis, 2010).

Antioxidants in this case can provide benefits to the immune systems. Antioxidants can inhibit free radicals and be inhibitors of lipid peroxidation that can prevent oxidative stress (Canene-Adams *et al.*, 2005; Basu and Imrhan, 2006). In this study, subjects were given antioxidant drinks as the intervention. The antioxidant drinks was tomato extracts and flavored-rice bran powder drink. Both of them evidently have high levels of antioxidants such as lycopene in tomatoes (Ramandeep and Geoffrey, 2005); oryzanol, tocopherols and tocotrienols in rice bran (Henderson *et al.*, 2012). The intervention of tomato extracts in 2 weeks show the increase of total antioxidant activity in women with cysts and non-cysts (Arza, 2010). The intervention of 30 g flavored-rice bran powder drink in 2 weeks can decrease plasma total cholesterol levels in women with breast cysts (Damayanthi *et al.*, 2011).

The purpose of this study was to analyze effect of antioxidant drinks intervention (tomato extracts and flavored-rice bran powder drinks) on titers of IgG in adults obesity used quasi-experimental one group pre and post-test design.

MATERIALS AND METHODS
Subjects: The target population in this study was the employees of Bogor Agricultural University. After screening, the employees who were classified as obesity (BMI$\geq$25 kg/m^2), not on medical treatment,

Corresponding Author: Siti Ika Fitrasyah, Department of Community Nutrition, Faculty of Human Ecology, Bogor Agricultural University, Bogor 16680, Indonesia

currently not suffering from any diseases that related to decrease on immune-function, not getting any intervention from the similar antioxidant drinks, not pregnant or breast-feeding and not being away out of town when the intervention was conducted were asked to become the subjects of this study and willing to fill the informed consent. From 20 employees who had passed the screening phase, then there were 13 subjects who met the inclusion criteria.

Data collection: Data in this study consisted of primary and secondary data. The primary data were the eating habits, food consumption frequency and titer of immunoglobulin G while the secondary data were the characteristics of obesity adults and BMI [(weight (kg)/(height (m)^2)] (Damayanthi *et al.*, 2014). The characteristics, eating habits and food consumption frequency data were collected once at baseline. BMI data were collected 3 times at the time of screening, baseline and endline while IgG titer data were collected 2 times at baseline and endline.

Two cups or 480 ml/day of tomato extracts was given to the subjects, which can be drunk hot or cold condition 2 times/day then the distribution of drinks once a week. Lycopene in 2 cups tomato extracts is approximately 45.8 mg (USDA-NCC carotenoids Database for US Foods, 1998). One sachet or 30 g day of flavored-rice bran powder drinks (can be selected as desired subjects) given to the subjects and can be drunk in warm or cold conditions. In the sachet is equivalent to 86.7 mg of oryzanol (Damayanthi *et al.*, 2013). To monitor the compliance of the subjects, they always to be reminded via SMS (short message service) phone on a periodically, then at the end of the study subjects's compliance data taken using a questionnaire (Hasan, 2014).

Data analysis: Data processing were included editing, coding, entry and cleaning. Data of sex consisted of male and female. Subjects's age were classified into early adults (20 to 40 years) and older adults (41 to 60 years) (Adriani and Wirjatmadi, 2012). The educational level were classified to elementary school or the equivalent, junior-high school or the equivalent, senior-high school or the equivalent and college or the equivalent. The marital status consisted of married and not married. Monthly family-income were classified into several categories, less than Rp 2,000,000; Rp 2,000,000 to less than Rp 3,000,000; Rp 3,000,000 to less than Rp 5,000,000 and more than Rp 5,000,000. The family size consisted of small family category (≤4 people) and large family category (≥4) (BKKBN, 1997). Eating habits consisted of breakfast habits; daily eating frequencies; snack-eating habits; over-eating when suffering from stress; food restrictions; preferred way of food processing and the consumption habits of

fast foods and soft drinks. Data of food consumption frequency of fatty foods, sweet foods, grains, vegetables and fruits were grouped into four groups consisting of 'every day', '4-6 times/week', '1-3 times/week' and 'never' consumption. The results are averaged with the unit of frequency per week. IgG titer were classified into several categories, below 700 mg/dl (low), 700 to 1600 mg/dl (enough) and above 1600 mg/dl (high). The IgG titer analysis also indicated from the shift of each participant before and after the intervention of tomato extracts and flavoured-rice bran powder drinks that concluded by titer difference.

Statistical analysis: Data analysis was performed in descriptive and inferential. Descriptive analysis included the calculation of the subjects percentage based on sex, age, education level, marital status, family income per month, family size, eating habits and frequencies of food consumption classification. The results of statistical tests performed to determine differences of the data diversity of all variables between groups at baseline that also categorized into groups of obese and overweight. Afterwards, normality data testing performed to all variables in advance used Shapiro-Wilk test. Wilcoxon test was used to analyze differences in immunoglobulin G titer each group before and after the interventions.

RESULTS
Subjects characteristics: Obesity was more widely (53.8%) experienced by female. The majority of the subjects (69.2%) were classified as older adults. The majority of subjects (53.8%) were classified in elementary-senior high school. The majority (76.9%) of subjects were already married. Almost half of the subjects (38.5%) were less than Rp 2,000,000 family income/month and most subjects (61.5%) were classified as large family.

If subjects were categorized as obese and overweight, the majority of obese subjects (66.7%) were female; about half of subjects (55.6%) were older adults; about half of subjects (55.6%) were educated with D3-S3; the majority of subjects (66.7%) were married; half of subjects (55.6%) had a family income/month less than Rp 2,000,000 and the majority of subjects (66.7%) belong to a large family. Subjects with overweight were dominated (75%) by men; entirely of subjects (100%) were older adults; the majority of subjects (75%) were elementary-senior high school education; entirely of subjects (100%) were married; half of subjects (50%) had a family income/month Rp 2,001,000 to 3,000, 000 and the other half of subjects had Rp 3,000,001 to 5,000,000 and half of subjects (50%) belong to the category of small family.

Eating habits: Obesity was in a half of subjects (53.8%) who had breakfast habits. About half of subjects (61.5%)

ate more 4 times/day. The majority of subjects (69.2%) rarely had snacks (1 to 6 times/week). The majority of subjects (84.6%) did not over eat when stressed. The majority of subjects (61.5%) did not have any food restrictions (51.4%). The majority of subjects (69.2%) liked to consume fried foods. The majority of subjects (61.5%) never ate fast foods for 1 last month and about half of subjects (53.8%) never consumed soft drinks.

If subjects were categorized as obese and overweight, in obese subjects, approximately half of subjects (55.6%) had breakfast habits; the majority of subjects (77.8%) ate more 4 times/day; the majority of subjects (66.7%) rarely had snacks; the majority of subjects (77.8%) did not over eat when stressed; the majority of subjects (77.8%) did not have any food restrictions; the majority of subjects (66.7%) liked to consume fried foods; the majority of subjects (66.7%) never ate fast foods and about half of subjects had never consume soft drinks. For overweight subjects, half of them (50%) had breakfast habits; dominated subjects (75%) ate 3 to 4 times/day; most subjects (75%) rarely had snacks; All of subjects (100%) did not over eat when stressed; most of the subjects (61.5%) did not have any food restrictions; most of subjects (75%) liked to consume fried foods; half of the subjects (50%) rarely ate fast foods and soft drinks while the other half (50%) never ate it.

Frequency of food consumption: Overall, obesity was in most of subjects (84.6%) that rarely consumed fat-contained foods. The most frequently food that was consumed by the majority obese subjects (77.8%) are meatballs, with an average consuming frequency of 0.9 times/week and average food weight of 60.4 g. Most subjects (76.9%) were classified as frequent consumer of sweet foods. The most frequently food that was consumed by a large majority subjects (77.8%) were sugar, with an average consumption frequency of 3.6 times/week and an average food weight 17.6 g. The majority subjects (84.6%) consumed grains and vegetables less than 3 servings/day. The seeds that were most consumed by minority subjects (23.1%) were brown rice, with an average consumption frequencies of 1.4 times/week and an average weight of 27.7 g. The vegetables that were most often consumed by all subjects (100%) were carrots, with an average consumption frequency of 2.5 times/week and an average food weight of 154.6 g. Most subjects (84.6%) consumed fruit less than 3 servings/day. The most frequently consumed fruits by this group were papaya and apple with an average consumption frequencies 2.2 times/week for both of it. The average food weight of this fruits were 54.1 and 185 g, respectively.

If subjects were categorized as obese and overweight, all of subjects (100%) consumed grains and vegetables

Table 1: Characteristics of the subjects

Variables	p-value
Sex	0.317
Age	0.083
Education	0.157
Marital status	0.157
Family income	0.257
Number of family member	0.317

*Wilcoxon test, $\alpha < 0.05$

Table 2: Eating habits and frequency of antioxidant food consumption of the subjects

Variables	p-value
Breakfast habits	0.564
Frequency eat a day	0.317
The habit of eating snacks	0.317
Overeat when stressed	0.157
Food taboos	0.157
The way most preferred food processing	1.000
Fast food consumption habits	1.000
Soft drink consumption habits	0.414
Grains and vegetables	0.157
Fruits	1.000

*Wilcoxon test, $\alpha < 0.05$

Table 3: Average of IgG titers of the subject before and after the interventions

Interventions	mg/dl±SD
Obese	
Before	431.390±243.931
After	401.220±329.857
Delta (Δ)	-30.178
p-value	0.034*
Overweight	
Before	288.510±174.817
After	323.310±212.697
Delta (Δ)	34.809
p-value	0.046*
Obesity	
Before	387.430±228.079
After	377.250±291.972
Delta (Δ)	-10.182
p-value	0.004*

*Wilcoxon test, $\alpha < 0.05$

less than 3 servings/day and most of subjects (77.8%) ate fruits less than 3 servings/day. On the overweight subjects, half of subjects (50%) ate grains and vegetables less than 3 servings/day and the other half took more than 3 servings/day and all of subjects (100%) ate fruits less than 3 servings/day.

Subjects's immunoglobulin G titer: After intervention in overweight subjects, the IgG titer decreased from 387.43 to 377.25 mg/dl which was categorized as low IgG titer. In addition, the average titer of IgG in obese subjects after intervention decreased from 431.39 to 401.22 mg/dl which was also categorized as low IgG titer. The average IgG titer subjects in overweight subjects had increased from 288.51 to 323.31 mg/dl which was categorized as low IgG titer.

Results of bivariate analysis: For the characteristics of the subjects, the results of difference test using the Wilcoxon test showed that there were no differences in sex, age, education, marital status, family income/month and family size on the subjects (p>0.05), it can be seen in Table 1. For eating habits, the different test results using the Wilcoxon test showed that there were no difference in the breakfast habits, daily eating frequencies, snack eating habits, over-eating when stressed, food restrictions and the preferred method of food processing, as well as consumption habits of fast foods and soft drinks on the subjects (p>0.05), it can be seen in Table 2. Moreover, different test results using the Wilcoxon test showed that there were no difference in the frequencies of food antioxidants on the subjects (p>0.05), it can be seen in Table 2.

Wilcoxon test results showed that there were significantly reduction on IgG titer in overweight subjects after intervention (p<0.05), it can be seen in Table 3. Wilcoxon test results also showed that there were significantly reduction on IgG titer in obese subjects after intervention (p<0.05) whereas overweight subjects there were significantly enhancement after the antioxidant drinks intervention (p<0.05).

DISCUSSION

Obesity was by almost half suffered of the female subjects. According to the result of Riskesdas in 2007 to 2013, the prevalence of obesity was higher on women with the percentages around 23.8 to 32.9%, while the men was only about 13.9 to 19.7% (Balitbangkes, 2008, 2013). This result also in line with the research results in the other developing country, like the one that was conducted by Janghorbani *et al.* (2007) in Iran. The conducted research in Iran also showed the same results that the obesity prevalence on women was higher than the men, with the percentages of 40.7 and 26.9%, respectively. Furthermore, Almatsier (2001) said that gender is one of the influential factor to the number of basal metabolisms. Man and woman with the same age, height and weight have a different body compositions. Woman tend to have more fat tissues and less muscles than man, so that woman is more at risk to obesity.

Based on the age categories, obesity occurred in the older adults. This condition had the same result as Sugianti *et al.* (2009) research in Jakarta and Janghorbani *et al.* (2007) in Iran that the obesity prevalence on older adult was higher, with the percentages of 35.6 and 14.3%, respectively, compared to the early adults with the percentage of 14.8 and 8.6% each. According to Almatsier (2001), the older adults have the fat proportions on fat tissues is getting higher, so the number of basal metabolisms decrease. Someone with a lower basal metabolisms speed tend to obese easier than the faster one.

In the education level categories, obesity was on almost half of the subjects with elementary-senior high school. This phenomena was in accordance with Sugianti *et al.* (2009) in Jakarta, who stated that people with a low education (10.9%) were more often to have obesity rather than the one with a higher education (10.1%). Waloya (2013) said that the causes of this phenomena is because a higher formal education could help people with their nutritional pilot, so it will affect the preference of the daily foods.

For marital status, obesity was dominated by married subjects. Sugianti *et al.* (2009), also found the same results in her research that was conducted in Jakarta who showed higher obesity prevalences on married subjects (30.5%) than single subjects (7.9%). The same result also found in another developing countries, such as in Iran by Janghorbani *et al.* (2007) and in Uzbekistan that was conducted by Mishra *et al.* (2006). These researches showed that married subjects tend to have higher obesity prevalences about 17 and 67.4% respectively than the single one which is 4.3 and 28.7% each. Janghorbani *et al.* (2007) concluded that after getting married, people tend to have less physical activity, changing dietary pattern and less focused on interesting things.

Obesity was dominated by family with a monthly income less than Rp 2,000,000. This result was in line with the previous result which showed obesity was tend to happen to poorly-educated people. This phenomena also found in Brazil urban areas during 1989-1997 periods, which shows a higher obesity prevalences on the most indigent category (42.6%) than the wealthy one (19.1%) (Monteiro *et al.*, 2000). From this result, Drewnowski and Specter (2004) assumed that a healthy dietary require a greater cost and not affordable for a family with a low-income. People with obesity tend to buy food that contain more energy with a low cost, while energy-dense food had a cheaper price than fruits and vegetables. Furthermore, an energy-dense food also had palatability and more preferred than the non energy-dense (Drewnowski, 1997; Mela, 1999; Drewnowski, 1999; Drewnowski and Specter, 2004).

In the category of family size, another result that found in this research was that a large family was tend to have obesity. Although the number of smaller family members allocated more food distribution, but opposite results in this study allegedly associated with a higher percentages of subjects with low-incomes. A large family could use the budget to buy food that contain a high density of energy but low cost (Drewnowski and Specter, 2004). This result was in contrast compared to the previous research by Sugianti *et al.* (2009) in Jakarta and Al-Riyami and Afifi (2003) who mentioned that a small family are tend to have obesity with a percentages of 28.4 and 52.7%, respectively, while a larger family only have a percentages about 23.9 and 47.3%.

Overall, the result showed that obesity was on almost half of the subjects who have a breakfast habits. These were in line with the research that conducted by Asri (2011) who mentioned that the vast majority (84%) of obese employees have breakfast habits. Although breakfast was recommended for its important role in energy regulation (Cho and Samuel, 2009).

In the category of daily eating frequencies, obesity dominated by subjects who ate more than 4 times/day. This condition was in contrary with the research that conducted by Asri (2011) who mentioned that obesity was more likely to happen to employees with eating frequencies around 1 to 2 times/day. But a different result showed by research that conducted by Howarth *et al.* (2007) in Honolulu, a daily eating frequencies with more than 3 times/day (75%) positively related to obesity on adults.

Based on the snack-eating habits, obesity was on the subjects who rarely ate a snack. Chips and biscuits were the most preferred snacks by subjects with a respective percentages of 61.5 and 30.8%. This result was in line with the research conducted by Asri (2011) who mentioned snack-eating habits on obese employees in IPB were higher on employees with snacks consumption frequencies around 1 to 3 times/day, which was categorized in 'rarely', compared to the employees with snacks consumption frequencies more than 3 times/day (12%). These results showed that eating snack could deliver more energies with less costs compared to fruits and vegetables, which potentially raise obesity (Buyuktuncer, 2010; Manios *et al.*, 2005).

Furthermore, it was also found that obesity was dominated by subjects who did not overeat when stressed. This condition was not in line with the research of Nishitani and Sakakibara (2006) who stated that employees with obesity (19.4%) were associated with psychological stress such as anxiety and discomfort that related to high tension in working which affected to eating behaviour compared to the non-obeses (10.6%). But furthermore, in research that conducted by Wildani (2012), it was mentioned that generally, employees tend to have a moderate level of stress (34.8%) than the serious level (32.6%). So it could be assumed that subjects with a moderate level of stress did not have a high-tension of work, so they didnt show any form of psychological stress and did not have any feeding behaviour problem.

This research also showed that obesity was by a majority of subjects who did not have any food restrictions. This condition thought to be related to the restrictions of nutrient intake (dietary restrictions) that could be seen on the Bill Henderson Protocol (BHP) about the draft laws of nutrition restrictions that beneficial to reduce toxicity (Mannion *et al.*, 2011). BHP draft laws contain the restriction of meat, milk product (except cottage cheese), gluten, sugar, fast food and alcohol consumption. But it's difficult to make a general conclusion about the restriction throughout these foods without calculating the nutritional needs of every individual which is an important consideration (Van, 2007; Mannion *et al.*, 2011). This thought to be a reason for the minority of the subjects to have food restrictions. Obesity dominated by subjects with fried food-processing preference. This situation was in line with the research results of Silitonga (2008) in Deli Serdang distric and Guallar-Castillo'n *et al.* (2007) in Spain. These researches stated that obese people who prefers a fried foods tend to have a high risk of encountering obesity with a percentages of each was about 71.7 and 19.9%. A fried food have a crunchy texture, aromatic, delicious and rich of fat, so it contains high dense-energy but a low satiety index. A low satiety index in fat (Blundell *et al.*, 1993; Guallar-Castillo'n *et al.*, 2007) probably associated with the poor ability to stimulate the production of insulin and leptin (Havel *et al.*, 1999; Guallar-Castillo'n *et al.*, 2007). Moreover, fat intake could stimulate a person to consume food aside its satiety effect.

It appeared that obesity was to majority of subjects that never ate fast foods. This condition also in line with Asri (2011) who found that there was only a small percentages of obese employees in IPB consume fast foods. It was assumed that the distance between IPB and the nearest fast foods restaurant were far enough to be reached and the price is relatively expensive, so the subjects tended to choose a non-fast foods in weekdays. But this result was contrary with the research conducted by Jeffery *et al.* (2006) in Minnesota who found the relation between workers and the high consumption of fast foods.

In soft drinks consumption, obesity was to more than a half subjects who never consumed any soft drinks. This phenomena was in line with the research result by Asri (2011) who found only a minority of obese employees in IPB consume soft drinks. In this case, subjects were suspected to be more interested in high-energy drinks and another sweet drinks like syrup (61.5%) and sweet tea (53.8%) that have a high glycemic index although relatively rarely consumed. Sweet drinks were associated with the increasing risk of obesity (Brown *et al.*, 2005; NHMRC, 2011; VicHealth Indicators Survey, 2012). Soft drinks and sweet drinks itself caused energy intake enhancement from other foods that also contain high glicemic index and if consumed could increase glucose levels rapidly in the blood and it could also increase appetite and decrease satiety (Vartanian *et al.*, 2007; VicHealth Indicators Survey, 2012).

Generally, subjects was dominated who consumed grains and vegetables less than 3 servings/day. This result was in line with Asri (2011) who shows that majority of obese employees in IPB are included in the 'rare' category, with grains eating frequencies of 2.1

times/week or less than 3 servings/day. For consumption of fruit, obesity was on subjects with fruit consumption less than 3 servings/day. The same result were found in research of Asri (2011) who showed that almost half of the obese employees in IPB are rarely consume fruits, with eating frequencies only 1.5 times/week or less than 3 servings/day. The declining trend of vegetables and fruits consumption on adults also showed by the result of Riskesdas that decreasing from 93.6 in 2007 to 93.5% in 2013 (Balitbangkes, 2008, 2013), which could be assumed as a factor in increasing of obesity.

The productions of IgG antibody started from the activation of lymphocytes that triggered by the IL-6 mediator release which help the differentiation of T and B lymphocytes. Lymphocytes is a leukocytes that can be found in blood and lymph tissues. The total lymphocytes level on subjects in this research with the same interventions were equally same. After intervention, decreasing on lymphocytes occurs on the obese subjects but not statistically significant (Damayanthi *et al.*, 2014). A low IgG titer indicated a recent infection, while a high titer is a sign of past immunity and a positive titer indicate a primary infection (AACC, 2014b). At the first time the bodies were infected (primary infection), human bodies will form IgM (immunoglobulin M) protein compound as a reaction to the entry of unknown creatures into bodies (Saskatchewan Ministry of Health, 2014). The existence of IgG indicated that immunity in the body has been formed. So, if the titers were positive, it indicated that the body had formed immunity to unknown objects that cause infection (Knott, 2010). In a normal condition, IgG titer will persist or tend to decrease (AACC, 2014a; CDC, 2012).

Overall in this research, the obese subjects encountered an IgG titer decreasing and classified as a low titer. This result was much lower compared to the research result of Gonzalez-Quintela (2007) in Spain who mentioned that person with a normal IMT have an amount of IgG titer about 1050 mg/dl, however it was not statistically significant (p>0.05). This result indicated that the immune systems, neither specific nor non-specific had been working well on the bodies of obese subjects that appropriate with the previous result which was related with the immune systems parameter that occur decreasing of lymphocyte level and leukocytes, decreasing of cholesterol level and fasting-blood glucose level normalization on the same subjects and intervention with this research (Damayanthi *et al.*, 2014). In this research, most of the IgG titer on subjects decreased after encounter intervention and classified as low titer. This result was much lower compared to the research of Gonzalez-Quintela (2007) in Spain who stated that obese person have an IgG titer about 1130 mg/dl and it's statistically significant (p<0.05). The opposite result appeared on overweight subjects. Most of the overweight subjects increased their IgG titer and

classified as low-titer. This result was also much lower compared to the research of Gonzalez-Quintela (2007) in Spain who stated that overweight person's titer is 1095 mg/dl, but not statitically significant (p>0.05). Compared to the research of Gonzalez-Quintela (2007), it could be concluded that IgG titer were proportional with IMT.

In a normal condition, IgG titer will be constant or tend to decrease (AACC, 2014a; CDC, 2012). The increasing of IgG titer indicated a primary infection if the level are above normal level (AACC, 2014b). Primary infection also suspected to be related with the increasing of hematocrit level, which is the proportion of red blood cells in blood (Pusparini, 2004). IgG titer on overweight subjects also increased and classified as a low titer so it was suspected that a recent infection formed in the subjects's body, but still did not reach the primary infection stage. This also could be seen from the subjects's hematocrit that increase from 45 to 45.5% after intervention, even it was only a slight difference before and after intervention (Damayanthi *et al.*, 2014). The same goes for the overweight-subjects's thrombocyte that increase from 302.750 to 316.000 per µl after intervention and it still on the normal level (Damayanthi *et al.*, 2014). The red-blood cell is thought to have a role in the increasing of IgG titer on overweight subjects. The antigen-antibody complex are dissolved in the blood, it is carried from the inflammation site of red-blood cells which express CR1 (Complement Receptor 1) that bound C3 (complement) that activated by C3b in the complex of immune. The complex of immune released by red-blood cells to the liver or spleen and then the red-blood cells is circulated back (Baratawidjaja and Rengganis, 2010).

The increasing of IgG titer which was a specific immune systems after intervention on overweight subjects was thought to be affected by nutritional-intake factor and nutrient status that affect immunocompetent and body respond to the oxidative-stress and immune disruption that bring negative effect on the utilization of nutrition and lead into microorganism threat or disease which could cause nutritional fault and immunodeficiency (Chandra, 1990; Palop and Martinez, 1997; Marti *et al.*, 2001). The extravagant supplies of certain nutrition could increase immunocompetent and also lead into several immunodeficiency (SanMartin and Chandra, 2000; Cunningham-Rundles, 1993; Marti *et al.*, 2001).

The disproportion of energy and body composition were caused by the intake and output of energies (Friedman, 2000; Marti *et al.*, 2001) that under control of three component, that were, food supplies, thermogeneses (could be triggered by nutrient intake, supplement and exercise) and adipocytes metabolism. This was also proved by observing nutrient-intake level and subjects's physical activity (Damayanthi *et al.*, 2014) and also the frequencies of antioxidant food consumption.

According to the research by Damayanthi *et al.* (2014), it was obtained that the average nutrient-consumption level based on the food intake in weekdays and weekend on the overweight subjects was higher than the obese. On the overweight subjects, an energy intake of 66% was classified as a serious deficit, a carbohydrate amount of 128% was excessive, 69% amount of protein classified as a serious deficit and a fat percentages of 71% was excessive. On the obese subjects, energy intake of 61% was classified as a serious deficit, an amount of carbohydrate about 79% was excessive, 63% of protein classified as a serious deficit and 66% of fat was classified excessive. Subjects's energy supplies classified as a serious level of deficit, but the intake of subjects's carbohydrate was excessive, while the main role of carbohydrate was as the source of energy. The supplies of protein itself classified as serious level of deficit, while the main role of protein is as the biochemical changing catalyst in the body like hormone and enzyme, which also help the ability of the bodies to do detoxification against toxic that also related to the formation of antibody, moreover, protein is also a source of energy. Even though the subjects's protein intake classified in a serious level of deficit, which served as the source of energy, but the subjects's fat intake classified excessive, whereas the role of fat is also the source of energy (Almatsier, 2009). So it could be concluded that the energy intake of obese subjects in this research is over the normal nutritional adequacy rate, with the overweight subjects that is tend to have a wrong dietary, so it contributed to the poor restoration of body cells from oxidative stress that related with the increasing IgG antibody formation as the result of the increasing infection.

And according to the previous result about the consumption of antioxidant food like grains, vegetables and fruits, after statistically analyzed it was found that the overweight subjects had a lower frequency of antioxidant food consumption than the obese subjects which is mentioned before. According to Almatsier (2010), the recommended serving of fruits and vegetable for adults is more than 3 servings/day. So it is concluded that the subjects did not meet the minimum requirement of antioxidant food consumption.

The antioxidant tissues that persist against ROS and free radicals had been much explained (Yu, 1994; Ji, 1995; Kris-Etherton *et al.*, 2004; Vincent and Taylor, 2006). This defense systems include non-enzymatic (antioxidant supplies, thiol contained components) and antioxidant enzyme. Vitamin E and C and also β-carotene is the main antioxidant supplies (Kris-Etherton *et al.*, 2004; Vincent and Taylor, 2006).

The increasing of IgG titer could also be caused by the existence of inhibitors that could detain the absorption of food's antioxidant substances that intervented like vitamin E, vitamin C and vitamin A. The absorption of vitamin E could be detained by the disturbance of fat absorption that cause vitamin E deficiency. This deficiency was caused by the tocopherol that it turns out to be absorbed in the food's fat and released and also absorbed when the fat is being digested (Murray, 2003) like in cystic fibrosis and the disturbance of lipid transport like on the beta-lipoproteinemia. The absorption of vitamin C could detain because the existence of substance like phytate and tannins on tea (Sandstrom, 2001). While the detained absorption of vitamin A is caused by the disturbance of carotene conversion to vitamin A or it could be happened by the absorbed carotene that did not convert into vitamin A, but stored in the fat (Almatsier, 2009).

Based on the research that conducted by Damayanthi *et al.* (2014), it was obtained that the average physical activity on overweight subjects, which is 1.6, are lower than the obese (1.63), but both of this were classified as mild-physical activity. Overall, subjects in this research tended to have mild level of physical activity. The disproportion energy intake that overcome the expense in the long periods of time, then the low level of physical activity and too much time spend for non-active physical activity related to the increasing risk of obesity (HSNSW, 2011).

So it can be included that the intervention during 2 weeks showed that the antioxidant drinks intervention, that were tomato extracts and flavoured-rice bran powder drinks, was able to give an effect on the restoration of immunity on subjects. It was thought that the antioxidant substance in tomato and rice bran were beneficial for body to restore the body's oxidative stress level, so it could be significantly effected the IgG titer (p<0.05).

Conclusion and recommendation: Characteristics between obese and overweight groups were relatively equal. Eating habits among obese and overweight groups were relatively equal too. Average IgG titers in subjects generally decreased. It is proved that the antioxidant drinks intervention consisted tomato and rice bran has been able to give effect to the improvement of the body's immune responses for each group.

According to the inadequacy in this research, therefore, a further research should be conducted by giving more duration on the antioxidant drinks intervention. Beside giving antioxidant drinks to subjects, it is necessary to give nutritional counseling during the research, so it could lead the subjects's life style into a better way. Therefore, it is needed to conduct a further research on antioxidant food intervention relation with adult's immune system.

this study. The author also would like to thank all respondents and traditional leaders in Bogor Agricultural University community who have been willing to be subjects in this study.

REFERENCES

AACC, (American Association for Clinical Chemistry), 2014a. Parvovirus; Parvo B19. [Homepage on the Internet]. Available from http://labtestsonline.org/understanding/analytes/parvo/tab/test/.

AACC, (American Association for Clinical Chemistry), 2014b. Cytomegalovirus antibody, IgG and IgM; Cytomegalovirus by PCR. [Homepage on the Internet]. Available from http://labtestsonline.org/understanding/analytes/cmv/tab/test/.

Adriani, M. and B. Wirjatmadi, 2012. Peranan gizi dalam siklus kehidupan (The role of nutrition in the life cycle). Jakarta: Kencana.

Aeberli, I., L. Molinari, G. Spinas, R. Lehmann, D. l'Allemand and M.B. Zimmermann, 2006. Dietary intakes of fat and antioxidant vitamins are predictors of subclinical inflammation in overweight Swiss children. Am. J. Clin. Nutr., 84: 748-755.

Almatsier, S., 2001. Prinsip dasar ilmu gizi (The basic principle of nutritional science). Jakarta: PT Gramedia Pustaka Utama.

Almatsier, S., 2009. Prinsip dasar ilmu gizi (The basic principle of nutritional science). Jakarta: PT Gramedia Pustaka Utama.

Almatsier, S., 2010. Penuntun diet (Guidance diet). Jakarta: PT Gramedia Pustaka Utama.

Al-Riyami, A.A. and M.M. Afifi, 2003. Prevalence and correlates of obesity and central obesity among Omani adults. Saudi Med. J., 24: 641-646.

Arza, P.A., 2010. Pengaruh pemberian jus tomat dan penyuluhan gizi terhadap status antioksidan likopen plasma dan gaya hidup penderita kista payudara (The effect of tomato juices and nutritional counseling to lycopene plasma antioxidant status and lifestyle of patients with breast cysts). Bogor: Institut Pertanian Bogor (Bogor Agricultural University).

Asri, D.M., 2011. Gaya hidup, intake zat gizi dan morbiditas orang dewasa yang berstatus gizi obes dan normal (Lifestyle, intake of nutrients and morbidity adults obese and normal nutritional status). Bogor: Institut Pertanian Bogor (Bogor Agricultural University).

Balitbangkes, Badan Penelitian dan Pengembangan Kesehatan (Agency for Health Research and Development), 2008. Laporan Riset Kesehatan Dasar Nasional (RISKESDAS) 2007 (Report of the National Association of Health Research (RISKESDAS) 2007). Jakarta: Balitbangkes, Departemen Kesehatan Republik Indonesia (Balitbangkes, Ministry of Health, Republic of Indonesia).

Balitbangkes, Badan Penelitian dan Pengembangan Kesehatan (Agency for Health Research and Development), 2010. Laporan Riset Kesehatan Dasar Nasional (RISKESDAS) 2010 (Report of the National Association of Health Research (RISKESDAS) 2010). Jakarta: Balitbangkes, Departemen Kesehatan Republik Indonesia (Balitbangkes, Ministry of Health, Republic of Indonesia).

Balitbangkes, Badan Penelitian dan Pengembangan Kesehatan (Agency for Health Research and Development), 2013. Laporan Riset Kesehatan Dasar Nasional (RISKESDAS) 2013 (Report of the National Association of Health Research (RISKESDAS) 2013). Jakarta: Balitbangkes, Departemen Kesehatan Republik Indonesia (Balitbangkes, Ministry of Health, Republic of Indonesia).

Baratawidjaja, K.G. and I. Rengganis, 2010. Imunologi dasar, edisi 9 (Basic immunology, 9th edition). Jakarta: Badan Penerbit Fakultas Kedokteran Universitas Indonesia (Agency Publisher Faculty of Medicine, University of Indonesia).

Basu, A. and V. Imrhan, 2006. Tomatoes versus lycopene in oxidative stress and carcinogenesis: conclusions from clinical trials. Eur. J. Clin. Nutr., 1-9.

BKKBN, Badan Koordinasi Keluarga Berencana Nasional (National Family Planning Coordinating Board), 1997. Konsep pengembangan "Kebijaksanaan kontrasepsi" dalam gerakan reproduktif keluarga sejahtera, cetakan pertama (The concept of development "Wisdom contraception" in the reproductive motion prosperous families, first printing). Jakarta: BKKBN.

Blundell, J.E., V.J. Burley, J.R. Cotton and C.L. Lawton, 1993. Dietary fat and the control of energy intake: evaluating the effects of fat on meal size and postmeal satiety. Am. J. Clin. Nutr., 57: 722-728.

Boynton, A., M.L. Neuhouser, M.H. Wener, B. Wood, B. Sorensen, Z. Chen-Levy, E.A. Kirk, Y. Yasui, K. LaCroix and A. McTiernan et al., 2007. Associations between healthy eating patterns and immune function or inflammation in overweight or obese postmenopausal women. Am. J. Clin. Nutr., 86: 1445-1455.

Brown, W.J., L. Williams, J.H. Ford, K. Ball and A.J. Dobson, 2005. Identifying the energy gap: Magnitude and determinants of 5-year weight gain in midage women. Obesity Res., 13: 1431-1441.

Buyuktuncer, Z., 2010. The obesity epidemic and its management. Int. J. Food Sci. and Technol., 45: 1753-1754.

Canene-Adams, K., J.K. Campbell, S. Zaripheh, E.H. Jeffery and J.W. Erdman, 2005. The tomato as a functional food. J. Nutr., 135: 1226-1230.

CDC, (Centers for Disease Control and Prevention), 2012. Laboratory guidance and diagnostic testing. [Homepage on the Internet]. Available from http://www.cdc.gov/dengue/clinicallab/laboratory.html.

Chandra, R.K., 1990. Nutrition and immunity: Lessons from the past and new insights into the future. Am. J. Clin. Nutr., 087-1101.

Cho, S.S. and P. Samuel, 2009. Fiber ingredients: Food applications and health benefits. CRC Press.

Cunningham-Rundles, S., 1993. Nutrient Modulation of the Immune Response. Academic Press: New York.

Damayanthi, E., L. Kustiyah, Kardinah and K. Roosita, 2011. Efektivitas jus tomat dan minuman bekatul terhadap pengecilan ukuran lesi kista payudara (Effectiveness and drinks tomato juices bran against breast cyst lesion size reduction). Indonesian J. Cancer Nat. Cancer Center, 5: 25-30.

Damayanthi, E., C.M. Dwiriani and Abdurohman, 2013. Minuman fungsional bubuk bekatul padi berflavor untuk pencegahan penyakit tidak menular dalam Prosiding peran teknologi dan industri pangan untuk percepatan tercapainya kedaulatan pangan Indonesia, Bidang analisa pangan dan pangan fungsional (Flavored-rice bran powder as functional drinks for the prevention of non-communicable diseases in Proceedings of the role of technology and the food industry to accelerate the achievement of Indonesian food sovereignty, food analysis fields and functional food). Seminar Nasional Perhimpunan Ahli Teknologi Pangan Indonesia (National Seminar of Indonesian Food Technology Experts Association), 38-50.

Damayanthi, E., C.M. Dwiriani, L. Kustiyah and M. Dewi, 2014. Pengkajian minuman bekatul, minyak bekatul dan tomat untuk kesehatan lipid dan kadar gula darah serta status imun orang dewasa gemuk (Assessment drinks bran, rice bran oil and tomatoes for healthy lipid and blood sugar levels and immune status of obese adults). Jakarta: *Institut Pertanian Bogor* (Bogor Agricultural University), siap terbit (ready published).

Drewnowski, A., 1997. Taste preferences and food intake. Annu. Rev. Nutr., 17: 237-53.

Drewnowski, A., 1999. Intense sweeteners and energy density of foods: Implications for weight control. Eur. J. Clin. Nutr., 53: 757-763.

Drewnowski, A. and S.E. Specter, 2004. Poverty and obesity: The role of energy density and energy costs. Am. J. Clin. Nutr., 79: 6-16.

Friedman, J.M., 2000. Obesity in the new millenium. Nat., 404: 632-635.

Furukawa, S., T. Fujita, M. Shimabukuro, I. Masanori, Y. Yamada, Y. Nakajima, O. Nakayama, M. Makishima, M. Matsuda and I. Shimomura, 2004. Increased oxidative stress in obesity and its impact on metabolic syndrome. J. Clin. Invest., 114: 1752-1761.

Gonzalez-Quintela, A., R. Alende, F. Gude, J. Campos, J. Rey, L.M. Meijide, C. Fernandez-Merino and C. Vidal, 2007. Serum levels of immunoglobulins (IgG, IgA, IgM) in a general adult population and their relationship with alcohol consumption, smoking and common metabolic abnormalities. Clin. and Exp. Immunol., doi:10.1111/j.1365-2249.03545.

Guallar-Castillo'n, P., F. Rodriguez-Artalejo, N.S. Fornes, J.R. Banegas, P.A. Etxezarreta, E. Ardanaz, A. Barricarte, M.D. Chirlaque, M.D. Iraeta and N.L. Larranaga *et al.*, 2007. Intake of fried foods is associated with obesity in the cohort of Spanish adults from the European Prospective Investigation into Cancer and Nutrition. Am. J. Clin. Nutr., 86: 198-205.

Hajer, G.R., van T.W. Haeften and F.L.J. Visseren, 2008. Adipose tissue dysfunction in obesity, diabetes and vascular diseases. Eur. Heart J., 29: 2959-2971.

Hasan, 2014. Pengaruh pemberian sari tomat, serbuk bekatul, dan emulsi minyak bekatul terhadap aktivitas antioksidan pada orang dewasa gemuk (Effect of tomato extracts, powdered rice bran and rice bran oil emulsion of antioxidant activity in obesity adults). Jakarta: Institut Pertanian Bogor (Bogor Agricultural University), siap terbit (ready published).

Havel, P.J., R. Townsend, L. Chaump and K. Teff, 1999. High-fat meals reduce 24-h circulating leptin concentrations in women. Diabetes, 48: 334-341.

Henderson, A.J., C.A. Ollila, A. Kumar, E.C. Borresen, K. Raina, R. Agarwal and E.P. Ryan, 2012. Chemopreventive properties of dietary rice bran: current status and future prospects. Adv. Nutr., 3: 643-653.

Howarth, N.C., T.T.K. Huang, S.B. Roberts, B.H. Lin and M.A. McCrory, 2007. Eating patterns and dietary composition in relation to BMI in younger and older adults. Int. J. Obesity, 31: 675-684.

HSNSW, (The Health Statistic New South Wales), 2011. Adult overweight and obesity [Homepage on the Internet]. Available from www.health.nsw.gov.au/.../hsnsw/pdf/adult_overweight_and_obes.pdf.

Janghorbani, M., M. Amini, W.C. Willett, M.M. Gouya, A. Delavari, S. Alikhani and A. Mahdavi, 2007. First nationwide survey of prevalence of overweight, underweight and abdominal obesity in Iranian adults. Obesity, 15: 2797-2808.

Jeffery, R.W., J. Baxter, M. McGuire and J. Linde, 2006. Are fast food restaurants an environmental risk factor for obesity?. Int. J. Behav. Nutr. and Phys. Activity, 3: 2.

Ji, L.L., 1995. Exercise and oxidative stress: Role of the cellular antioxidant systems. Exer. Sport Sci. Rev. 23: 135-166.

Knott, L. Brucellosis, 2010. Homepage on the Internet. September 2010. [diunduh 2014 Agustus 20]. Available from http://www.patient.co.uk/doctor/Brucellosis.htm.

Kris-Etherton, P.M., A.H. Lichtenstein, B.V. Howard, D. Steinberg and J.L. Witztum, 2004. Antioxidant vitamin supplements and cardiovascular disease. Circulation, 110: 637-641.

Manios, Y., F. Magkos, G. Christakis and A.G. Kafatos, 2005. Twenty-Year dynamics in adiposity and blood lipids of Greek children: Regional differences in crete persist. Acta Paediatrica, 94: 859-865.

Mannion, C., S. Page and M. Verhoef, 2011. Components of an anticancer diet: Dietary recommendations, restrictions and supplements of the Bill Henderson Protocol. Nutr., 3: 1-26.

Marti, A., A. Marcos and J.A. Martinez, 2001. Obesity and immune function relationships. Obesity Rev., 2: 131-140.

Mela, D.J., 1999. Food choice and intake: The human factor. Proc. Nutr. Soc., 58: 513-521.

Mishra, V., F. Arnold, G. Semenov, R. Hong and A. Mukuria, 2006. Epidemiology of obesity and hypertension and related risk factors in Uzbekistan. Eur. J. Clin. Nutr., 1355-1366.

Monteiro, C.A., M.H.D. Benicio'A, W.L. Conde and B.M. Popkin, 2000. Shifting obesity trends in Brazil. Eur. J. Clin. Nutr., 54: 342-346.

Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodwell, 2003. Biokimia Harper, edisi 25 (Harper Biochemistry, 25th edition). Jakarta: Penerbit Buku Kedokteran (Book Medical Publishers).

NHMRC, (National Health and Medical Research Council), 2011. A review of the evidence to address targeted questions to inform the revision of the Australian Dietary Guidelines. Canberra: NHMRC.

Nishitani, N. and H. Sakakibara, 2006. Relationship of obesity to job stress and eating behavior in male Japanese workers. Int. J. Obesity, 30: 528-533.

Otto, T.C. and M.D. Lane, 2005. Adipose development: From stem cell to adipocyte. Crit. Rev. Biochem. Mol. Biol., 40: 229-242.

Palop, L. and J.A. Martinez, 1997. Cross-sectional assessment of nutritional and immune status in renal patiens undergoing continuous ambulatory peritoneal dialysis. Am. J. Clin. Nutr., 66: 498-504.

Pusparini, 2004. Kadar hematokrit dan trombosit sebagai indikator diagnosis infeksi dengue primer dan sekunder (Hematocrit and platelets as an indicator of diagnosis of primary and secondary dengue infection). J. Kedokter Trisakti, 23.

Ramandeep, T.K. and P.S. Geoffrey, 2005. Antioxidant activity in different fractions of tomatoes. Food Res. Int., 38: 487-494.

Sandstrom, B., 2001. Micronutrient interactions: effects on absorption and bioavailability. Br. J. Nutr., 85: 181-185.

Sanmartin, S. and R.K. Chandra, 2000. Obesity, overnutrition and immune system. Nutr. Res., 21: 243-262.

Saskatchewan Ministry of Health, 2014. Immigrant immunization resources. [Homepage on the Internet]. Available from http://www.health.gov.sk.ca/sim-chapter14.

Silitonga, N., 2008. Pola makan dan aktivitas fisik pada orang dewasa yang mengalami obesitas dari keluarga miskin di Desa Marindal II Kecamatan Patumbak Kabupaten Deli Serdang tahun 2008 (Diet and physical activity in adults who are obese from poor families in the village Marindal II District Patumbak Deli Serdang 2008). Medan: Universitas Sumatera Utara (University of North Sumatra).

Sugianti, E., Hardinsyah and N. Afriansyah, 2009. Faktor risiko obesitas sentral pada orang dewasa di DKI Jakarta: Analisis lanjut data Riskesdas 2007 (Central obesity risk factors in adults in Jakarta: Further analysis of the data Riskesdas 2007). Gizi Indon (Nutrition Indon), 32: 105-116.

USDA, (United States Department of Agriculture), 1998. USDA-NCC carotenoid database for U.S. foods [Homepage on the Internet]. Available from http://www.ars.usda.gov/News/docs.htm?docid=9447.

Van, H.L., 2007. Nutritional research: The power behind the Fad-Free diet. J. Am. Diet. Assoc., 107: 371.

Vartanian, L.R., M.B. Schwartz and K.D. Brownell, 2007. Effects of soft drink consumption on nutrition and health: A systematic review and meta-analysis. Am. J. Public Health, 97: 667.

VicHealth Indicators Survey, 2012. Healthy eating-soft drink consumption. Victorian Health Promotion Foundation. K-040-KN.

Vincent, H.K. and A.G. Taylor, 2006. Biomarkers and potential mechanisms of obesity-induced oxidant stress in humans. Int. J. Obesity, 30: 400-418.

Wellen, K.E. and G.S. Hotamisligil, 2005. Inflammation, stress and diabetes. J. Clin. Invest., 115: 1111-1119.

Waloya, T., 2013. Hubungan antara konsumsi pangan dan aktivitas fisik dengan kadar kolesterol darah pria dan wanita dewasa di Bogor (The relationship between food consumption and physical activity with blood cholesterol levels in adult men and women Bogor). Bogor: Institut Pertanian Bogor (Bogor Agricultural University).

Wildani, A.A., 2012. Gambaran tingkat stres kerja pada pegawai Dinas Kesehatan Kota Depok (The level of work stress on employee Depok City Health Department). Depok: Universitas Indonesia (University of Indonesia).

Yu, B.P., 1994. Cellular defenses against damage from reactive oxygen species. Physiol. Rev., 74: 139-162.