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## **Potential Use of Gamma Irradiated Ethnic Meal Ready to Eat Foods to Improve Nutritional Status of School-Children**

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### **Abstract**

Children grow with lack of nutrition circumstances including family food security, living style, and bad quality of food intake may lead a serious infection disease and reduce the immune system in their body. This “hunger paradox” is mainly attributed to lack of sanitation and food hygiene practices, lowlevel education etc. Intervention studies of good quality of foods on selected undernourished children to improve their nutritional status and immune system in Sentul, Bogor has been conducted. The sample population was the students at purposive elementary school, about 10-12 years old and mostly undernourished children. Some teachers and parents were approached to participate this study. Purpose of this activity is to collect some information from the clinically healthy students, but they are suspected undernourished based on inclusion criteria such as body weight and height, chronicle disease, hemoglobin content, and conditional eating habit. Each student must complete an inform consent sheet prior to food intervention.

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About 90 selected students were randomly split into three groups, 30 children each, and then treated with three different types of foods continuously for 25 days. Each group received unirradiated, irradiated, and regular foods, respectively. Anthropometry measurement including body weight and height. Blood serum such as albumin, lymphocyte, and hemoglobin were measured according to the methods of previous work, and observed at an accredited clinical laboratory in Bogor as pre and post-tests, respectively. The unirradiated and irradiated foods were prepared based on high protein content in the products as developed for immune-compromised patients. Nutrition intake was carried out according to the method of food recall within 2 x 24 hours. Eating habit and illness history, education level of parents, and other valuable information were recorded according to Food Frequency Questionnaire (FFQ). Irradiated various ethnic RTE foods provided some benefits compared to either unirradiated or regular foods, such as more variation in menu and longer shelf life, and it might help to improve nutrition status of undernourished schoolchildren.

**Keywords:** immune systems; infection disease; irradiated ethnic foods; undernourished children; variation of menu.

## **1. Introduction**

Irradiation offers a potential benefit to enhance microbiological safety of food, and of accept nutritional and sensory quality through shelf-life extension. The revised regulation of food irradiation in Indonesia is already in place. The regulation, No. 701/MENKES/PER/VIII/2009, has been stipulated under the decree of Ministry of Health of the Republic of Indonesia on 28 August 2009 [1].

Food irradiation is a non-thermal process, so the treated food is close to the natural state both in appearance and taste unlike other technical processes involving heat treatment which may lead to some unacceptable changes in food [2-4]. Ready to eat (RTE) foods can be pasteurized or sterilized by irradiation in the final package and then reheated by microwave cooking prior to serve, and some nutritional losses may occur insignificantly [5]. For certain category of consumers, it is necessary to supply the diet with additional vitamins and specific nutrients. Nevertheless loosing of micro and macro nutrients can be suppressed by selecting appropriate irradiation conditions, and proper packaging material used in this purpose [6]. Centre for Isotopes and Radiation Application (CAIR) National Nuclear Energy Agency has successfully developed various types of irradiated ethnic ready to eat foods and conducted its risk assessment intensively [7-10]. Unfortunately, little data were available on the effect of irradiation on minimally processed food and composite food as well as prepared meals administered to specific target groups including malnourished schoolchildren.

Children at the age ranging from 10-12 years old are mostly having eating problem at breakfast time [11]. It has been intensively studied by some researchers [12-13] that breakfast improves children learning ability. School children breakfast can reach a memory test scores, test problem solving, better in academic achievement than children who skipped breakfast. Children are delaying breakfast will also cause weakness in understanding the task at school. Breakfast may improve cognitive function related to memory test grades and school attendance. The objective of the research work was to investigate supplementation effect of irradiated foods at breakfast time on the nutrition status of schoolchildren including the malnourished students at elementary schools.

## 2. Materials and Methods

### *Preparation of irradiated RTE foods*

Different types of ethnic ready to eat foods, were mostly protein source, namely bacem tofu (@ 100g), presto milk fish (@100 g), pepes gold fish (@100g) rendang beef (@50g) and semur beef (@50g) were prepared by three different medium food enterprises i.e. Bogor, Surabaya, and Bekasi,. Rice was served fresh immediately during supplementation study. Irradiation treatment was done at IRKA cobalt-60 irradiator, CAIR Jakarta at a dose rate of 5 kGy/h. Bacemtofu and presto milk fish were irradiated at medium dose of 8 kGy at low temperature (0-3°C) along the process. Other irradiated samples, i.e. radiation sterilization of (RTE) foods based on two types of animal origins, including fish base (*pepes* gold fish), meat base (*rendang* beef and *semur* beef )were also prepared in order to study the effects of sterile foods on nutritional status the respondents. Dry ice were purchased from a dry ice making-company in Jakarta, and the selected packaging materials used were Polyester/Al-foil/LLDPE for sterile foods, meanwhile Nylon/PE was used as packaging material for *bacem* tofu and *presto* milk fish, respectively. Styrofoam box with dimension of  $l \times w \times h = 51.25 \times 36.25 \times 33.75 \text{ cm}^3$  was used to keep the products during and after irradiation. Unirradiated ethnic RTE foods as control sample were also performed during the work.

Pre and post-test during intervention studies such as Body Mass Index including body weight and height were measured using a calibrated weighing scale and microtoise, respectively. A Skin Fold Caliper (SFC) was used as a tool to measure Body Fat Mass (BFM) in biceps. Blood was collected by an accredited clinical laboratory in Bogor for further analysis on hemoglobin, albumin and total lymphocyte counts.

### *Administrative matters*

Research proposal and an ethical clearance (Figure 1) regarding the study should be submitted to different governmental institutions to obtain letter of approval to conduct the study. An oral introduction was presented by researchers explained about purpose, benefit for students and school, etc. It was performed by researchers in front of school teachers, parents, and school children, at separate of time. Supplementation of the unirradiated and irradiated foods is conducted at Elementary public school, Sentul village, Bogor West Java with the school children as respondents.

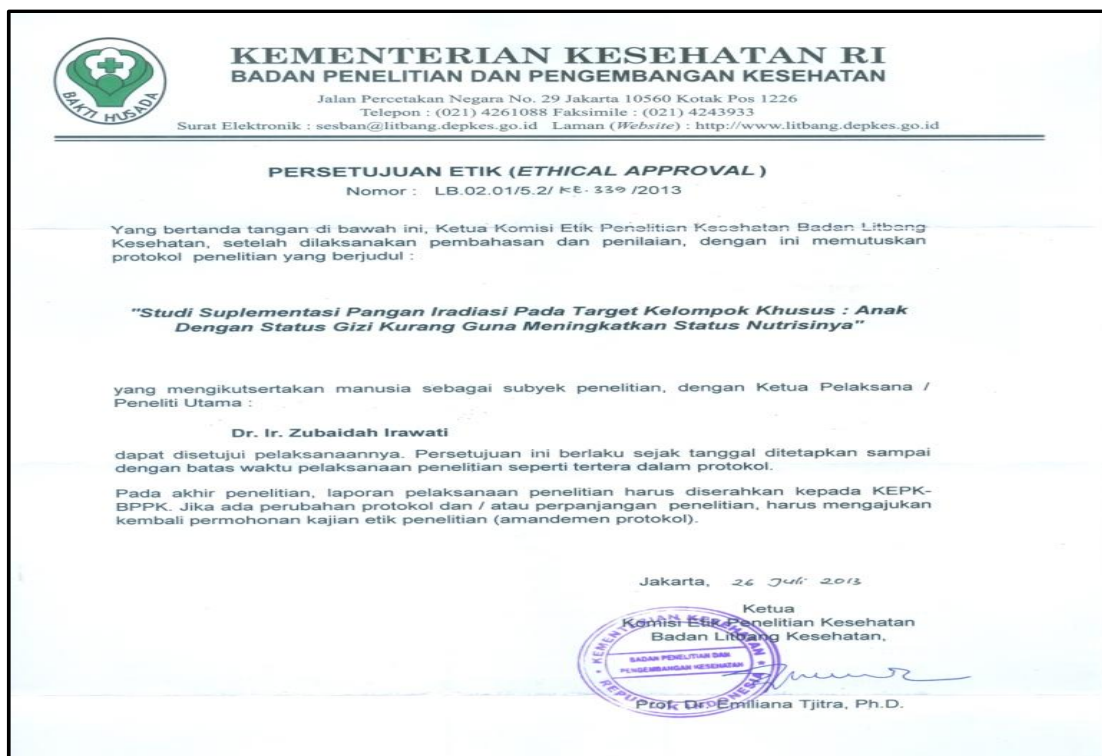
### *Supplementation study*

Human population act as respondent will be used in this research work. The flow diagram of the whole activity is illustrated in Figure2. The school children, in terms of sample population, was the main target by supplementing unirradiated and irradiated foods only at breakfast time starting from 7 up to 9 a.m. Irradiation pasteurization and sterilization RTE foods were administered to the school children as sample respondents and carried out for 25 days using a method from the previous study [14-15]. The selected residents, people fulfilled inclusion criteria, were randomized then split into 3 intervention groups and each group consist of 30 children, received different type of food. The supplementation of the irradiated and unirradiated ethnic RTE foods (Table 1), conducted immediately after pre-test : anthropometry measurement [16] and blood serum collection. The

groups will again receive some information regarding the purpose of supplementation study, how to do, and nutrition education prior to test. Group I will be control. Students only have, or does not, have conventional breakfast at home. Group II is treated with some unirradiated foods prepared by BATAN, and Group III was treated with some main meals irradiated foods prepared by BATAN. Group II and group III. Body Fat Mass (BFM) measurement was applied to monitor the effect of diet on muscle tissue and fat. The measurement was applied at biceps only and it is estimated according to the method of Durnin and Womersley [17].

### *Standard methodologies and techniques applied for quality assessments*

Irradiation treatments of the foods were conducted according to Good Radiation Practices while the foods were prepared according to Good Handling Practices and Good Manufacturing Practices, and Standard Operating Procedure (SOP). Calculation of SFC measurement, Body Mass Index (BMI) and Percent Body Fat were estimated [16]. Blood samples were collected from individual respondent for pre and post-test analysis according to the following parameters such as albumin, hemoglobin, and lymphocytes contents. The assessments of the blood were conducted in an accredited Private Clinical Laboratory Services in Bogor, This measurement may indicate nutrition status and determine the potential risk of degenerative disease of the respondent. The quality of the individual type of ethnic RTE foods was evaluated based on subjective measures represented as sensory evaluations such as general appearance, texture, flavour, taste, and odour according to Hedonic scale at 5 degree of preference conducted by the schoolchildren, and it was taken by random during having meal.



**Figure 1:** Ethical approval to conduct the study was obtained from The Ministry of Health, The Republic of Indonesia.

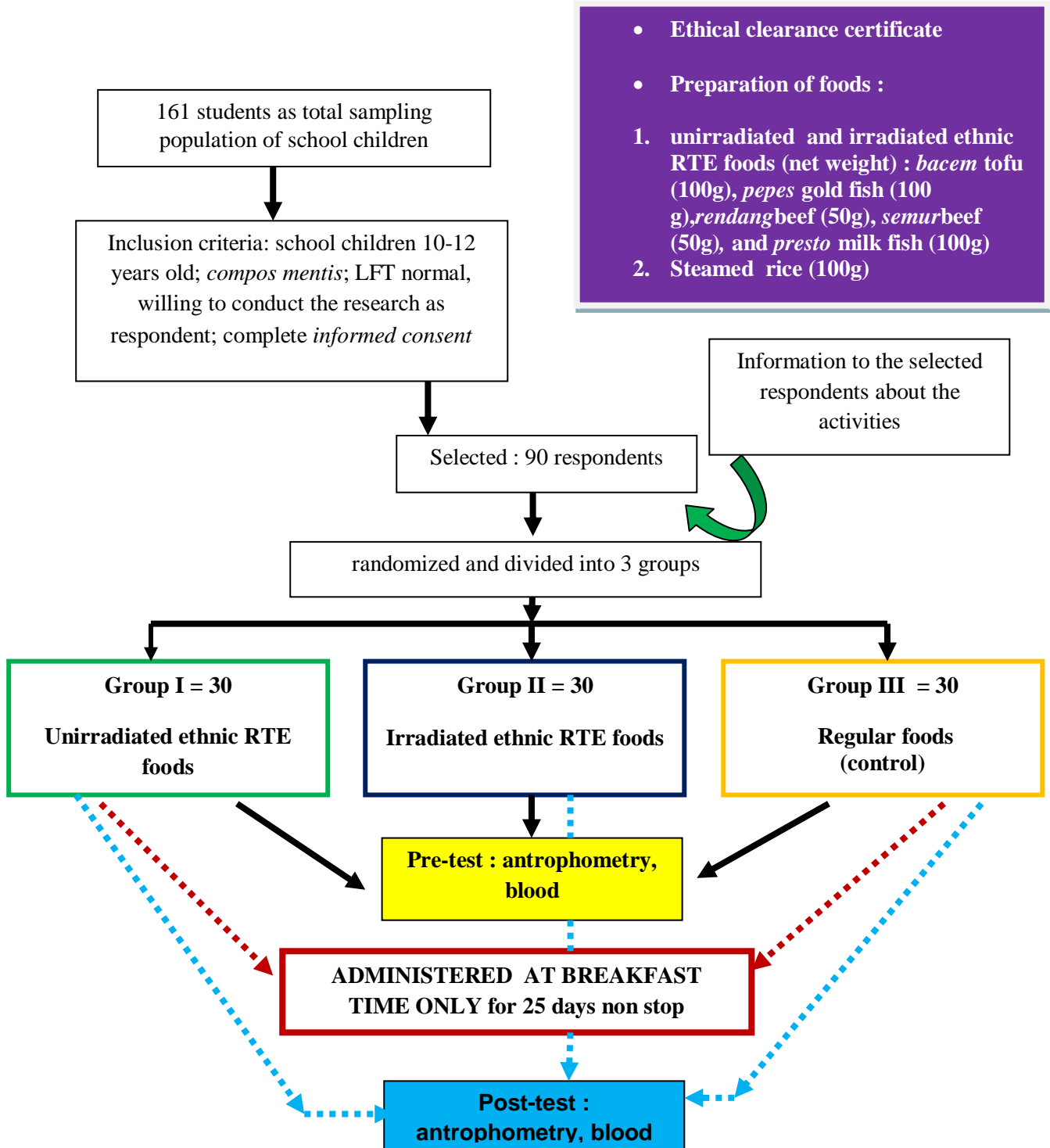


Figure 2: Flow diagram of pre and post-tests during intervention activities at elementary school

### 3. Results and Discussion

Considering most healthy children, foodborne illness is not life threatening but undernourished children living

at with lack of nutrition may have greater risk for developing life threatening complications from a foodborne illness. It is well known that irradiation greatly combat insectsparasites and bacteria that initially contaminate foods. Irradiation can drastically reduce the presence of these disease-causing agents, providing a much broader margin of safety. Used in combination with other food safety measures, it can drastically reduce the risk of illness for consumers [14].

**Table 1:**Cyclus of 5 day menu for 25 days duration of intervention studies on ethnic ready to eat foods administered to schoolchildren at breakfast time.

Day-	Type of breakfast
1 <sup>st</sup>	Rice and <i>presto</i> milk fish
2 <sup>nd</sup>	Rice and <i>semur</i> beef
3 <sup>rd</sup>	Rice and bacem tofu
4 <sup>th</sup>	Rice and pepes gold fish
5 <sup>th</sup>	Rice and rendang beef
6 <sup>th</sup>	Rice and presto milk fish
7 <sup>th</sup>	Rice and semur beef
8 <sup>th</sup>	Rice and bacem tofu
9 <sup>th</sup>	Rice and pepes gold fish
10 <sup>th</sup>	Rice and rendang beef
11 <sup>th</sup>	Rice and presto milk fish
12 <sup>th</sup>	Rice and semur beef
13 <sup>th</sup>	Rice and bacem tofu
14 <sup>th</sup>	Rice and pepes gold fish
15 <sup>th</sup>	Rice and rendang beef
16 <sup>th</sup>	Rice and presto milk fish
17 <sup>th</sup>	Rice and semur beef
18 <sup>th</sup>	Rice and bacem tofu
19 <sup>th</sup>	Rice and rendang beef
20 <sup>th</sup>	Rice and bacem tofu
21 <sup>th</sup>	Rice and rendang beef
22 <sup>th</sup>	Rice and bacem tofu
23 <sup>th</sup>	Rice and semur beef
24 <sup>th</sup>	Rice and pepes gold fish
25 <sup>th</sup>	Rice and rendang beef

Results of anthropometry and blood serum both at pre and post-tests is presented in Table 1. BMI (kg/m<sup>2</sup>) of all groups mostly stable before and after the tests while biceps measurement of each group showed an increase after intervention. It seems that habitual breakfast consumption is associated with BMI. Schoolchildren in group III

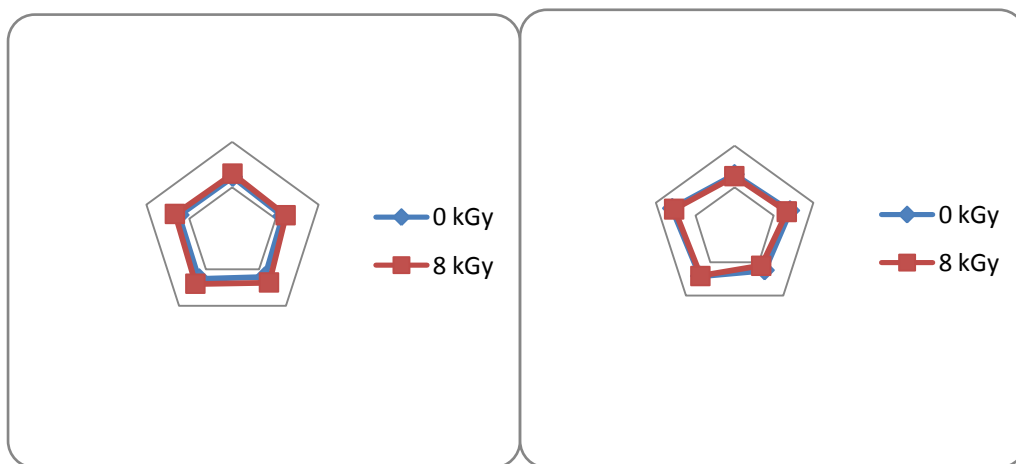
were encouraged during the evaluation to have breakfast more regularly. It can be seen from the values that biceps measurement and total lymphocyte count tend to increase at post-test. Total lymphocyte count of blood serum respondent in all groups showed an increase during treatment as indicated at post-test. The highest value was achieved by group II at post-test (41.7%).

**Table 2:** Results of anthropometry and blood test of respondents before (pre-test) and after intervention ethnic ready to eat foods (post-test) of three different groups.

Parameter	Group I* (n= 30)	Group II** (n= 30)	Group III*** (n= 30)
BMI (kg/m <sup>2</sup> ) pre test	16.6	16.2	17.0
BMI (kg/m <sup>2</sup> ) post test	17.5	16.9	17.7
Biceps (mm) pre test	4.8	4.3	4.7
Biceps (mm) post test	5.8	5.0	6.3
Albumin (g/dL) pre test	4.5	4.6	4.6
Albumin (g/dL) post test	4.9	4.8	4.9
Hb (g/dL) pre test	12.9	12.9	13.1
Hb (g/dL) post test	12.9	12.7	13.0
Total Lymphocyte Counts (%) pre test	41.7	39.1	38.8
Total Lymphocyte Counts (%) post test	40.4	41.7	39.6

**Note:**

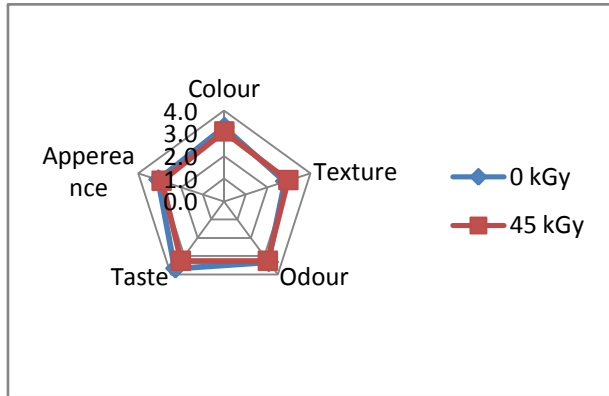
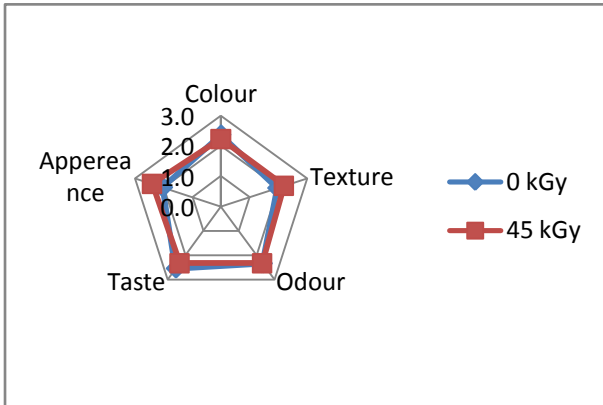
- \*) Respondents consumed unirradiated ethnic ready to eat foods
- \*\*) Respondents consumed irradiated ethnic ready to eat foods
- \*\*\*) Respondents consumed ordinary foods (control)



**Figure 3:** Sensory evaluation of bacem tofu

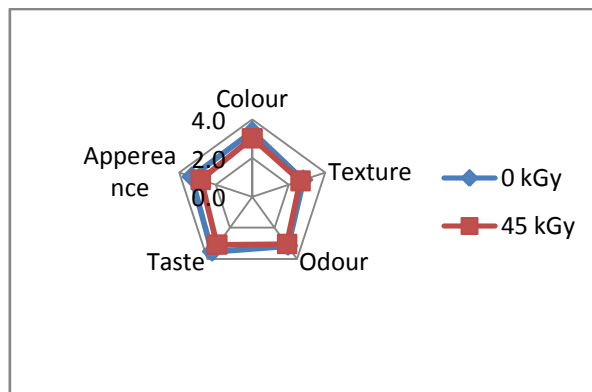
**Figure 4:** Sensory evaluation of presto milk fish.

The results of sensory evaluation of different types of ethnic ready to eat foods: unirradiated and irradiated treatments are illustrated in Figures 3-7. It is shown that some respondents in each group mostly like all types of irradiated ethnic ready to eat foods. According to the questionnaire that was distributed among respondents during the test, pepes gold fish was the most favourite meals and followed by *semur* beef and *rendang* beef, rather than the other meals.



**Figure 5:** Sensory evaluation of *pepes* gold fish.

**Figure 6:** Sensory evaluation of *semur* beef.



**Figure 7:** Sensory evaluation of *rendang* beef.

#### 4. Conclusion

High quality of foods such as gamma irradiated various types of ethnic ready to eat foods either at medium dose (8 kGy) or high dose (45kGy) in combination with other techniques might improve the nutritional status of schoolchildren. Conducting research with school children need great effort (to consolidate with infra-structure: parents, school teacher, public leaders, local government, and the children). Eating habit showed great impact on the school children behaviour during the tests. Copying positive behave among students might give better impact to the others.



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