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Effects of Consuming Yellowstripe Scad versus Salmon on Lipid Profile, Fasting Glucose, Body Weight Status and Blood Pressure among Healthy Overweight Malaysian Adults

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ABSTRACT

Introduction: This is a preliminary result of an on-going randomised cross-over trial to compare the effects of consuming yellowstripe scad (YSS) and salmon, both rich in omega-3 fatty acids, on lipid profile, fasting glucose, body weight status, and blood pressure among healthy overweight adults. **Methods:** Fifty healthy overweight Malaysians aged 21-55 years were recruited voluntarily through advertisements. During the first period of intervention, subjects were randomised equally to receive eight weeks of either steamed whole YSS fish (YSS group) or salmon fillet (salmon group), three days per week, obtaining approximately 7000 mg EPA+DHA per week. The diets were switched after an eight-week washout period. Lipid profile, fasting glucose, body mass index, and blood pressure were evaluated before and after each intervention period. **Results:** The mean ages of YSS group (n=25) and salmon (n=25) group were 30.6±9.1 and 27.9±7.1 years respectively. Both groups had no statistically significant differences on socio-demographic characteristics (p>0.05). After the first intervention period, there was a significant increase in total cholesterol within the YSS group (p<0.05) but not within the salmon group (p>0.05). Both YSS and salmon groups had significantly higher HDL-cholesterol levels after 8 weeks compared to baseline (p<0.05). There was no significant between-group difference in all the variables after eight weeks (time x group interaction, p>0.05). However, there was a significant effect of time on diastolic blood pressure (p<0.05). **Conclusion:** These preliminary findings indicate that YSS and salmon may have similar beneficial effects on HDL-cholesterol level among healthy overweight adults. The second intervention period is on-going to confirm these findings.

Key words: Dietary fish, healthy overweight adults, lipid profile, omega-3 fatty acids, randomised cross-over trial

INTRODUCTION

Dyslipidaemia is a condition characterised by elevated cholesterol or/and triglycerides, or a low high-density lipoprotein level (Goldberg, 2015). These lipid abnormalities are frequent complications of overweight and obesity (Wietlisbach *et al.*, 2013) that greatly affect the population worldwide. Data from Global Health Observatory (GHO) indicates that more than one-third of the global adult population had raised total cholesterol (Wold Health Organization, 2017). In Malaysia, the prevalence of hypercholesterolemia is 47.7 % with most of the cases (80.0 %) being newly diagnosed

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(Institute for Public Health, 2015). The growing number has raised much concern because dyslipidaemia may hide a hidden burden of atherosclerosis and coronary heart disease (Lee *et al.*, 2017), which would be a great financial burden to the country. According to a study done by Zhang *et al.*(2017), hyperlipidaemia significantly increases the medical expenditure and the increase is higher in people with cardiovascular diseases.

Multiple efforts have recently been devoted towards promoting disease prevention through the healthy control of lipid profile. For example, the American College of Cardiology (ACC) and the American Heart Association (AHA) established a set of guidelines on the management of blood cholesterol to reduce atherosclerotic cardiovascular disease risk in adults (Stone *et al.,* 2014). The guidelines established that lifestyle changes, including a healthy diet, remain the foundation for cholesterol-lowering drug therapy, providing strong support over the role of diet in improving lipid profile. Several observational studies have demonstrated favourable association between long term fish consumption and lipid profile (Kim *et al.*, 2015; Tørris, Molin & Småstuen, 2017) and the findings are supported by intervention studies with lipid-lowering effects of fish demonstrated by Lankinen *et al.* (2014) and Vazquez *et al.* (2014). The beneficial effect of dietary fish on lipid profile is suggested to be mainly contributed by omega-3 fatty acids (Zhang *et al.*, 2012).

Omega-3 fatty acids are essential polyunsaturated fatty acids that must be obtained from the diet. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are the two main long-chain omega-3 fatty acids commonly found in marine sources (Nettleton, 2012). Marine fish, especially salmon, is the principal source of EPA and DHA (United States Department of Agriculture, 2017). However, for tropical countries like Malaysia, salmon is very costly and needs to be imported from other cold climate countries such as Norway. Recently, yellowstripe scad (YSS, *ikan selar kuning*), a local fish in Malaysia, was identified as providing a comparable EPA+DHA content (Abd Aziz *et al.*, 2012) as salmon sold in supermarkets (Blanchet *et al.*, 2005) (879 mg/100 g vs. 947 mg/100 g). YSS is not only cheap but commonly available in Malaysia throughout the year. Since YSS and salmon have comparable EPA+DHA content, it is meaningful to investigate if both fish species could have similar beneficial health properties. In this study, we report the preliminary findings of the effects of YSS compared with salmon on lipid profile, fasting glucose, body weight status, and blood pressure after the first intervention period among healthy overweight adults.

METHODS

Subjects

Fifty healthy overweight (mean BMI 25.3 kg/m^2) Malaysian adults aged 21-55 years were recruited from staff and students of Universiti Putra Malaysia (UPM). Subjects were considered ineligible if they self-reported chronic diseases; were receiving warfarin/aspirin treatment, or medication to lower blood lipids, blood pressure, and inflammation; were menopausal, pregnant, or lactating; or were consuming fish twice or more per week, or taking fish oil supplements for the last one month. At the first intervention period, four subjects were discontinued from the study − three due to difficulties in following the diet and the other due to menopause.

Study design

This preliminary study reports the results from the first intervention period of an on-going randomised, two-period, crossover trial. It was conducted with two 8-week intervention periods and an 8-week washout period in-between from October 2016 to May 2017 under free living conditions in accordance with the Declaration of Helsinki. The study protocol was approved by the Ethics Committee for Research Involving Human Subjects UPM (JKEUPM, the acroynm in Malay) and registered in the National Medical Research Register (NMRR-16-2693-3230). Written consent was obtained from all the subjects and an identification number was assigned to each subject. Subjects were randomised into two equal-sized groups of YSS and salmon. Lunchbox was provided to the subjects three times (days) per week during weekdays for eight weeks in each intervention period. Throughout the intervention, subjects were instructed to completely refrain from consuming omega-3 rich food but otherwise to keep their diets constant. Subject compliance was assessed on the basis of two-dimensional food images (Dahl Lassen *et al.*, 2010), whereby subjects were instructed to send images of lunchbox (including possible leftovers) after the meal. Deviations from the diets were recorded and a compliance index was calculated based on the following formula (Wandless *et al.*, 1979):

$$\text{Compliance index (\%)} = \frac{\text{[(Total number of lunchbox consumed)}}{\text{Total number of lunchbox theoritically required}} \times 100$$

Only minor deviations occurred and all the subjects achieved a compliance index of 90%. Fasting blood samples, anthropometric measurements (weight and height), and blood pressure were taken before and after each intervention period. Subjects were instructed to fast for at least 8 hours prior to the blood sample collection day.

Diets

The diets were administered in the form of lunch box using plastic containers, which contained steamed fish dishes served with one serving of cooked white rice and vegetable side dishes. Each group consumed exactly the same foods except for the type of fish. They were given either steamed YSS (*Selaroides leptolepis*, YSS group) or salmon (*Salmo salar*, salmon group). Subjects received the same type of fish throughout the 8-week intervention period.

Before the intervention, a qualitative survey was conducted to evaluate the palatability and acceptance of steamed fish. The questions included "*Which type of cooked fish do you prefer the most?*", "*To what extent do you like to eat steamed fish? (1 = Least, 5 = Most)*", "*What do you feel on the following attributes (taste, appearance, quality, health/nutritional value, price, and others) that affect your preference for steamed fish? (Please elaborate and give reasons)*", "*Do you have any suggestions on what can be done to improve your preference for steamed fish?*" Subjects' feedback was taken into consideration when planning the menu. The menu of diets is given in Table 1.

YSS was given in the form of whole fish (≈385 g/day, corresponding to ≈265 g fillet/day) while salmon was in the form of fillet (≈246 g/day), providing approximately 2300 mg EPA+DHA per day (≈7000 mg per week). The amount of fish provided was defined based on Abd Aziz *et al.*(2012) and Blanchet *et al.*(2005) respectively to meet the recommended intake of omega-3 fatty acids, which was approximately 1000 mg per day (Ministry of Health Malaysia, 2014), corresponding to about 7000 mg per week. International guidelines recommend fish consumption three times (servings) per week (Reiner *et al.*, 2011).

Whole YSS was provided rather than YSS fillet because it is smaller in size and to fillet it would be difficult and impractical. Since there was variation in weight between whole fish and fillet of YSS, an experiment on determining the net weight of YSS fillet was conducted by measuring the initial weight (whole fish) and final weight (fillet) of YSS after removing the head, bones and tail. Based on the results

Table 1. Menu of diets

Fish dishes	*Vegetable side dishes*
Steamed fish with soy sauce	Vegetable salad
Steamed fish with oyster sauce	Cucumber pickles
Steamed fish with black pepper sauce	Stir fried mixed vegetables
Steamed fish with Barbecue sauce	(such as cauliflower, carrot, long bean, and cabbage)
Steamed fish with Thai sauce	
Steamed fish with lime sauce	
Steamed fish with sweet and sour sauce	
Steamed fish with chilli sauce	

Table 2. Baseline characteristics of subjects between diet groups

	YSS (*n* = 25)	*Salmon* (*n* = 25)
Age[1] (years), mean (SD)	30.6 (9.1)	27.9 (7.1)
Sex[2], n (%)		
Male	8 (32.0)	9 (36.0)
Female	17 (68.0)	16 (64.0)
Ethnicity[3], n (%)		
Malay	20 (80.0)	16 (64.0)
Chinese	4 (16.0)	8 (32.0)
Indian	1 (4.0)	1 (4.0)

No significant difference between diet groups by [1] independent-samples *t*-test, [2] Pearson chi square test, [3] Fisher's exact test.

(data not shown), an additional weight of 45.1 % was calculated taking into account the head, bones and tail when portioning whole YSS fish.

All the fish were wrapped in aluminium foil and steamed based on the modified method from Koubaa *et al.*(2012) for 20 min using double-layer food steamer. Steaming was selected as the cooking method because it has been shown to retain the most EPA+DHA content (Choo, 2015).

Outcome measures

The outcome measures of the study were lipid profile, fasting glucose, body weight status, and blood pressure. Blood profiles were analysed by an established medical diagnostic laboratory (Clinipath Malaysia Sdn. Bhd., Selangor, Malaysia). Body mass index was calculated as weight/height^2.

Statistical analysis

Data was analysed using IBM SPSS Statistics version 23. This preliminary interim analysis followed an intention-to-treat principle. Categorical variables were expressed as frequency and percentage while continuous variables as mean and standard deviation (SD). Between-group comparisons of socio-demographic characteristics were made using Pearson chi-square test (Fisher's exact test was applied if more than 20% of the cells had expected frequencies below five) for categorical variables and independent-samples *t*-test for continuous variables. Paired-samples *t*-test was used to determine the changes in all the variables after eight weeks on respective diet groups. Differences in outcome measures between diet groups were assessed by two-way mixed ANOVA. All statistical tests were performed at a significance level of 0.05 (two-sided).

RESULTS

The baseline characteristics of subjects are presented in Table 2. The mean age of subjects was 30.6±9.1 years in the YSS group and 27.9±7.1 years in the salmon group. There were no statistically significant differences in age, sex, and ethnicity between diet groups. Mean baseline BMI of YSS group was 25.5 kg/m^2 and in salmon group, it was 25.1 kg/m^2.

Table 3 shows the changes in lipid profile, fasting glucose, body weight status, and blood pressure after first intervention period within and between diet groups. After 8 weeks, there was a significant increase in TC compared with baseline in the YSS group (+0.3 mmol/L, p<0.05) but not in the salmon group (+0.1 mmol/L, p>0.05). Meanwhile, HDL-C saw a significant increase within the YSS and salmon groups respectively (+0.1 mmol/L, p<0.05). Other variables were not changed significantly after the first intervention period within both diet groups (p>0.05).

There were no significant interactions between time and diet groups on all the variables. The main effect of time on diastolic BP was significant but the main effect of treatment on diastolic BP was not significant. In other words, diastolic BP level was significantly reduced after a 8-week intervention period, while diastolic BP levels of subjects from the YSS and salmon groups were not significantly different. For other variables, the main effects of either time or diet groups were not significant.

DISCUSSION

The on-going intervention is being conducted among healthy overweight adults, to compare the health effects between YSS (local fish) and salmon (imported fish). This preliminary report discusses the changes in lipid profile, fasting glucose, body weight status, and blood pressure after consumption of these dietary fish for eight weeks. The intervention period of 8 weeks was chosen as this time frame was shown to be sufficient to incorporate omega-3 fatty acids into tissues (Browning *et al.*, 2012) and to induce notable effects in serum concentrations of TAG, apolipoprotein (apo) B, apo C-II and apo C-III (Zhang *et al.*, 2012).

The preliminary analysis identified that both YSS and salmon diets substantially improved HDL-C levels but had no effect on other lipid profiles, with the exception of a significant increase in total cholesterol by YSS diet, after the first intervention period compared with baseline. These results are comparable with an earlier cross-over trial conducted by Lindqvist *et al.* (2007) which enrolled 15 healthy obese adults to compare the effect between herring fish and fillets of pork and chicken on several cardiovascular risk factors. The results found that the 4-week herring-rich diet significantly raised the HDL particle but had no effect on other lipids compared to another diet. The finding was similar even when Lindqvist *et al.* (2009) repeated the study among a higher number of subjects (35 healthy overweight men) and longer treatment period (6 weeks for each diet). The present study has thus preliminarily re-emphasised the results from previous studies that fish containing omega-3 fatty acids have more effect on HDL-C than other lipids. The significant increase in total cholesterol within the YSS group could be explained based on Friedewald equation[(LDL-C)=(TC)–(HDL-C)–(TG/5)] (Friedewald, Levy & Frederikson, 1972), whereby when HDL-C and LDL-C increase with TG remaining constant, total cholesterol increases.

The beneficial effect of these dietary fish on HDL-C is thought to be due to the enhancement of reverse cholesterol transport through peroxisome proliferator-

Table 3. Changes in lipid profile, fasting glucose, body weight status, and blood pressure after first intervention period (8 weeks) within and between diet groups

Variables	*YSS (n=23)*			*Salmon (n=23)*			*p-value*[2]		
	Baseline	*8 week*	*p-value*[1]	*Baseline*	*8 week*	*p-value*[1]	*Time*	*Group*	*Time x Group*
Lipid profile (mmol/L)									
TC	5.2 (0.8)	5.4 (1.0)	<0.05	5.3 (1.4)	5.4 (0.9)	ns	ns	ns	ns
HDL-C	1.5 (0.2)	1.6 (0.3)	<0.05	1.6 (0.4)	1.7 (0.3)	<0.05	ns	ns	ns
LDL-C	3.2 (0.8)	3.3 (1.0)	ns	3.2 (1.1)	3.3 (0.9)	ns	ns	ns	ns
TG	1.1 (0.5)	1.1 (0.4)	ns	0.9 (0.5)	0.9 (0.4)	ns	ns	ns	ns
VLDL-C	0.5 (0.2)	0.5 (0.2)	ns	0.4 (0.2)	0.4 (0.2)	ns	ns	ns	ns
Fasting glucose (mmol/L)	4.8 (1.1)	4.7 (0.5)	ns	4.7 (0.4)	4.7 (0.6)	ns	ns	ns	ns
BMI (kg/m^2)	25.5 (1.5)	25.4 (1.5)	ns	25.1 (1.6)	25.0 (1.8)	ns	ns	ns	ns
Systolic BP (mm Hg)	117 (10)	118 (11)	ns	113 (8)	117 (8)	ns	ns	ns	ns
Diastolic BP (mm Hg)	77 (6)	76 (7)	ns	74 (7)	74 (5)	ns	<0.05	ns	ns

TC: total cholesterol; HDL-C: high density lipoprotein-cholesterol; LDL-C: low density lipoprotein-cholesterol; TG: triglycerides; VLDL-C: very low density lipoprotein-cholesterol; BMI: body mass index; BP: blood pressure
All values are mean (SD).
[1] Determined by paired-samples *t*-test
[2] Determined by two-way mixed ANOVA adjusted for sex, age, and ethnicity
ns: not significant

activated receptor (PPAR) activation induced by omega-3 fatty acids (Nishimoto *et al.*, 2009). However, it should be noted that subjects in both diet groups had relatively high baseline HDL-C levels. The mean HDL-C level at baseline was 1.5±0.2 mmol/L for YSS group and 1.6±0.4 mmol/L for salmon group. According to Adult Treatment Panel III (2002), HDL-C of ≥1.55 mmol/L (60 mg/dL) is considered protective against cardiovascular disease and is associated with one less risk factor from the total count. The present observation is surprising since overweight individuals generally have lower HDL-C level (Pietiläinen *et al.*, 2009). Nevertheless, it is undeniable that the improvement in HDL-C level following a diet with dietary fish containing omega-3 fatty acids does play a role in protecting against diseases, particularly cardiovascular disease (Ali *et al.*, 2012).

Apart from lipid profile, there were no significant changes found in fasting glucose, BMI, and blood pressure after the first intervention period within both YSS and salmon groups. It had been proposed elsewhere that the intervention effect may depend on the baseline characteristics, whereby the beneficial changes induced by fish may appear larger when subjects had low baseline EPA and DHA status (Colussi *et al.*, 2014). Red blood cell EPA+DHA analysis of the subjects is on-going in the present study to confirm that such factors could explain the insignificant changes in our study.

In the present study, YSS and salmon diets induced similar beneficial effects. The observation is expected since both diets were identical except for the types of fish (YSS or salmon). Indeed, these fish provided relatively similar omega-3 fatty acid content. This emphasises the evidence that the effects of YSS and salmon on lipid profile are likely attributable to the omega-3 fatty acid content.

It would be interesting to follow up the changes in diastolic BP since reduction of diastolic BP was shown after 8 weeks among healthy overweight subjects in the present study. The changes over time could be postulated by the high baseline BMI of subjects since BMI is highly associated with diastolic BP (Papathanasiou *et al.*, 2015). The observation was recorded when the main effect of time on diastolic BP was not significant, $F(1,4)=4.209$, $p=0.739$ after adjustment for baseline BMI (data not shown). Our findings are consistent with the results of Stewart *et al.* (2008) who reported that reduction in blood pressure was evident only in persons with higher baseline BP.

Fish oil supplements are widely used by the population for health benefits. Unfortunately, dietary fish has shown to have higher bioavailability (Harris *et al.*, 2007; Kris-Etherton & Hill, 2008) and more pronounced health effects (Elvevoll *et al.*, 2006) than fish oil from supplements. Furthermore, fish oil is highly susceptible to oxidation and the process of oxidative deterioration would result in nutrient loss and the development of off-flavours (Choe & Min, 2006). The replacement of other animal sources with fish in diet may also provide further health benefits since fish contains less saturated fatty acids and cholesterol than other sources of animal protein, and is also high in omega-3 fatty acids. Therefore, these preliminary findings may open up a more cost-efficient treatment of dyslipidaemia for overweight individuals.

A limitation of the study is that the portion of fish given did not reflect a normal intake. In order to elucidate the beneficial health effects of yellowstripe scad (YSS) and salmon in eight weeks by meeting the omega-3 intake recommendation (≈7000 mg/week)(Ministry of Health Malaysia 2014), the amount of fish given was nearly twice the recommended serving size (150 g) (Heart Foundation, 2008). Although our results demonstrated that short-term consumption of such amounts of fish is feasible, it is unlikely to be sustainable in the longer term. We acknowledge that fish consumption frequency could be increased to five times per day so that the portion size of fish to be given per time could be reduced to the recommended serving size.

CONCLUSION

Eight weeks consumption of YSS and salmon may contribute to beneficial health effects, particularly on HDL-C level even though TC level was also noticeably increased in the YSS group. The benefits of YSS and salmon on lipid profile of healthy overweight adults may be similar, which could add value to this commonly found fish in Malaysia, YSS. It is hoped that further analysis during the second intervention period will establish the health benefits of YSS.

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