



# Innovation of *Nugilempudu* (Lemuru Fish Nugget with Durian Seed Flour) in Affecting The Expression of Insuline-Like Growth Factor-1 among Stunted Children

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## Abstract

North Sumatera is the fifth province with highest number of stunting cases among children in Indonesia. More than 40% (42.3%) of stunting cases result in learning difficulties and decreased school performance which is thought to be related to alteration of brain development. Our study is to investigate the effect of *Nugilempudu* in the expression of Insuline-Like Growth Factor-1 (IGF-1) among stunted children. Study was conducted by using posttest with control design. 36 school-aged children were grouped into intervention (n=18) dan control (n=18) group. Intervention group received *Nugilempudu* daily for 4 weeks. The expression of IGF-1 was then assessed after intervention is completed by using ELISA method. We found that upon completing the administration of *Nugilempudu*, no statistically different concentration of IGF-1 expression was shown in both groups ( $p$  0.086). This indicated that *Nugilempudu* is potential to catch up the concentration of IGF-1 expression among stunted children with that in normal children. *Nugilempudu* can be an appropriate alternative or supplementary diet in enhancing the treatment of stunting, particularly in school-aged children.

**Keywords:** IGF-1, stunting, fish nugget, lemuru fish, durian seed flour

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## INTRODUCTION

Inadequate nutritional intake along with frequent infection have been shown to increase risk of stunting.[1] Proper administration of complementary food for 6-month old infants, improving mother's nutritional intake, accessible health service, and appropriate hygiene and sanitation are among rigorous efforts to exert in order to provide solution for stunting. Unfortunately, most of the previously mentioned efforts are

more likely to be unsustainable, particularly among school-aged children (6 – 12 years of age)[2,3].

According to Riskesdas (Fundamental Health Research) of Indonesia in 2010, 35% of school-aged students suffered from stunting. Stunting is more likely to be found in rural areas (41.7%) and only 29.3% is found in the city. In 2013, Riskesdas reported decrease in stunting prevalence to 30.7%[4,5]. In spite of



the decreased prevalence, Indonesia still cannot be considered being successful in overcoming stunting, as WHO expected that stunting prevalence should not be more than 28%[4,6]. Furthermore, North Sumatera is the fifth province with highest prevalence of stunting among school-aged children (42.3%)[7].

Stunting is related to learning difficulties and decreased school performance. These have been linked to altered neurodevelopment in the brain which is related to responses, such as visual, auditory, and thinking process. Stunted children are also more likely to experience decreased motoric ability as stunting also results in alteration of growth. This leads to decreased productivity and increased risk of getting infection.<sup>5</sup> Stunted children should have become priority, and supplementary food enriched with calcium, zinc, and protein can be the treatment of choice. Previous study which supplemented *Lemuru* (*Sardanellemuru*) fish nugget in stunted infants of 13 – 36 months old for consecutive 21 days has shown to improve average Z-score around -0.21 which nearly reached median value.[8]

Highly nutritious supplementary diet is appropriate as alternative solution in overcoming stunting as inadequacy of nutritional intake is shown to decrease the expression of IGF-1 receptor in the bones, leading to stunted linear growth of children. Our study innovated in creating fish nuggets from *Lemuru* fish, but instead of using commonly used wheat flour, we substituted it

with durian seed flour. This durian seed flour was chosen as it serves as high source of protein, zinc, and magnesium that are critical in children's linear growth. Thus, our study is to assess the effect of *Lemuru* fish nugget with durian seed flour among elementary school students of SDN (Public Elementary School) 104255 in PaluhSibaji, District of Pantai Labu, Deli Serdang, North Sumatera.

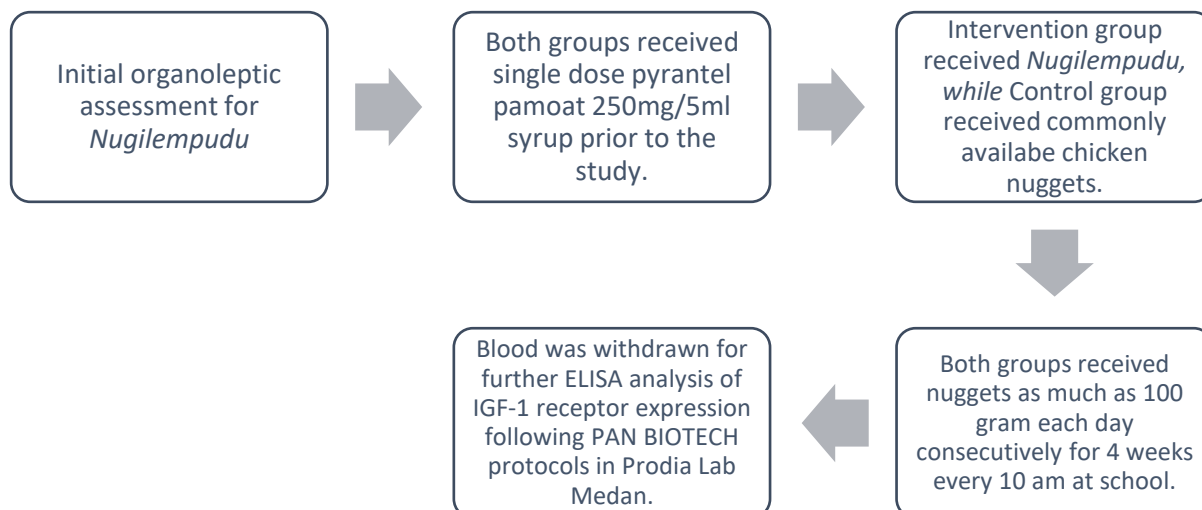
## METHOD

This clinical intervention with the design of posttest with control was conducted in elementary school in PaluhSibaji, District of Pantai Labu, Deli Serdang, North Sumatera. 36 school-aged children were grouped into intervention (n=18) and control (n=18) group. Intervention group received *Nugilempudu* daily for 4 weeks. The expression of IGF-1 was then assessed after intervention is completed by using ELISA method in nationally accredited clinical laboratory. Data were then statistically examined by using Anova Pearson Product Moment.

In completing the study, we were assisted with enumerators that were students from Dietetics major. Our study has gained ethical approval from PoltekkesKemenkes Ethical Committee number 01.1853/KEPK/PoltekkesKemenkes Medan/2021. Eligible subjects were 36 children age 10 – 12 years of age with no history of food allergy (especially for fish), are not currently suffering from worm infection, and whose parents had provided consent after informed consent was given.

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## RESULTS

Organoleptic study was conducted to assess the nutritional content of *Nugilempudu* per 100 gram of serving (as shown in Table 1). It is found that each 100 gram of

*Nugilempudu* contains 50% of durian seed flour substitute which is the source of carbohydrate as well as protein, zinc, calcium, magnesium, and iron that are importantly required for growth.

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Parameters	Unit	Value	Method
Water	%(b/b)	60,0	SNI 01-2891-1992
Residue	%(b/b)	14,9	SNI 01-2891-1992
Protein	%(b/b)	9,33	SNI 01-2891-1992
Carbohydrate	%(b/b)	10,7	SNI 01-2891-1992
Fat	%(b/b)	3,88	SNI 01-2891-1992
Phosphor	%(b/b)	0,39	SNI 01-2891-1992
Zinc (Zn)	mg/kg	20,9	Spectrophotometry
Kalsium (Ca)	mg/kg	1217,6	A A S
Magnesium (Mg)	mg/kg	120,7	A A S
Iron	mg/kg	13,1	A A S

**Table 1.** Nutritional value of *Lemuru* fish nugget with durian seed flour (*Nugilempudu*) per 100 gram serving.

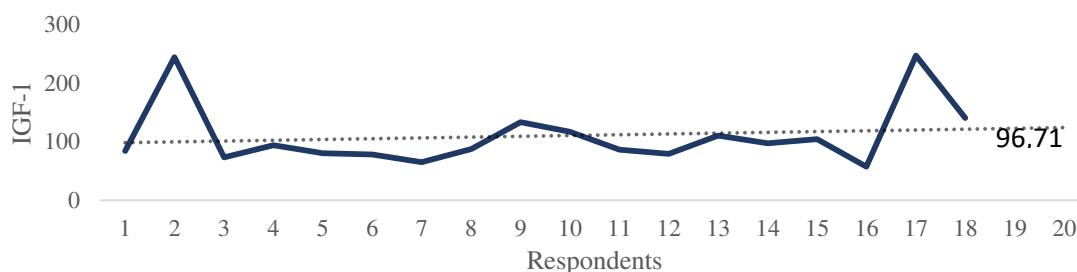
Our study found that after completing 4 weeks of dietary supplementation with *Nugilempudu*, there is no significant difference in the expression of IGF-1 in both intervention and control group. Interestingly we also found that low IGF-1 expression was also present among 10 year old children in control group (79.05 ng/ml, CI 95%).

Groups (Age in Years)	N	IGF-1 Concentration (ng/mL)				
		min	max	Mean (ng/mL) CI 95%	Anova Sig	LSD Sig
				Mean (ng/mL)	min	max



Control 10	9	104.33	64	161	79.05	129.61		0.688
Intervention 10	8	92.62	65	133	72.35	112.90		
Control 11	9	171.67	66	324	105.75	237.58	0.045	0.086
Intervention 11	10	123.40	57	247	75	171.80		

**Table 2.** Mean differences in the expression of IGF-1 in both control and intervention groups. Graph 1 also showed that dietary supplementation with 100 gram of *Nugilempudu* once daily for consecutively 4 weeks was able to improve IGF-1 expression as much as 96.71 ng/ml.



**Figure 1.** Expression of IGF-1 in stunted children after supplementation with *Nugilempudu*.

## DISCUSSION

Dietary supplementation with *Nugilempudu* once daily for 4 weeks consecutively results in insignificant difference of IGF-1 expression in both intervention and control group. IGF-1 expression concentration was also found in accordance to Prodia Lab reference; children age 10 years old: 88 – 452 ng/ml, 11 years old: 111 – 551 ng/ml, children age 12 years old: 143 – 693 ng/ml. Therefore, it can be seen that IGF-1 concentration in intervention group is lower compared to control group, but still is within normal range. Even though the difference is insignificant, this data actually showed that supplementation with *Nugilempudu* is potential to catch up the concentration of IGF-1 as it is in normal or non-stunted children.

IGF-1 expression is known to be regulated by growth hormone which is actually not an immediate signaling mechanism. The effect of growth hormone on IGF-1 expression may take months to years to be clinically apparent. Stunting, in the other hand, is a chronic process induced by nutrient deficiency which also takes long to overcome. It has been postulated that IGF-1 expression is related to stunting, but it doesn't serve as single contributing risk factor. In our study, the fact that IGF-1 concentration among 10 years old

children from control group that was actually below the normal range still poses a big question, thus, further investigation is necessary.

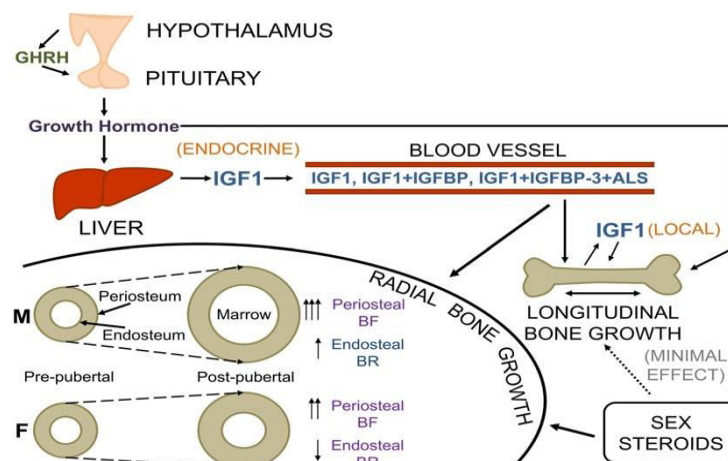
*Nugilempudu* serves as nutritious resource of protein, calcium, and zinc that are highly important for cell formations, particularly in bones. Inadequate dietary intake results in downregulation of growth hormone receptor which in turn leads to decreased expression of IGF-1. Decreased expression of IGF-1 is related to increased degradation of IGF-1.[9] Furthermore, protein restriction results in alteration of osteoblast, in which it becomes more resistant to IGF-1 activation. Resistance of osteoblasts to IGF-1 stimulation has been shown to be related to slower recovery of bone fractures, indicating slower rate of bone formation.[10] Growth hormone effect on bones is mediated through endocrine pathway, and leads to modulation of IGF-1 in the liver to further stimulate bone formation.

In the other hand, sex steroid plays relatively minor role in longitudinal bone growth of epiphyseal plate (in femur, tibia, fibula, and humerus). Longitudinal bone growth can be objectively evaluated by measuring children's height. Furthermore, sex steroid - IGF-1 signaling also modulates radial bone growth



which results in addition of bone width that is known to exhibit sexual dimorphism (bones in

boys are more likely to be wider than girls').[11]



**Figure 2.** IGF-1 modulation on bones.  
 Courtesy of Linsey and Mohan, 2016.

IGF-1 expression can be altered by hormonal anabolic factor, nutritional status, and inflammation. In particular, IGF-1 expression exhibited anti-inflammatory properties which results in decreased of inflammation and oxidative stress. This anti-inflammatory process requires other factors, such as selenium, zinc, magnesium, as well as adequate protein and energy intake.[9]

### CONCLUSION

Dietary supplementation of *Nugilempuduis* potential to catch up the concentration of IGF-1 as it is in normal or non-stunted children. Thus, *Nugilempuducan* be an appropriate alternative or supplementary diet in enhancing the treatment of stunting, particularly in school-aged children.

### ACKNOWLEDGEMENT

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### CONFLICT OF INTEREST

None to declare

### ETHICAL CLEARENCE

Our study has received approval from Research Ethical Committee of Indonesia's Ministry of Health's Polytechnic of Health Science, Medan; Number 0i.1853/KEPK/PoltekkesKemenkes Medan/2021.

Prior to the beginning of the study verbal and written explanation regarding our study was given to parents. Only children whose parents already gave written consent that were involved in the study. Participants can terminate participation at any point of the study.

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